Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

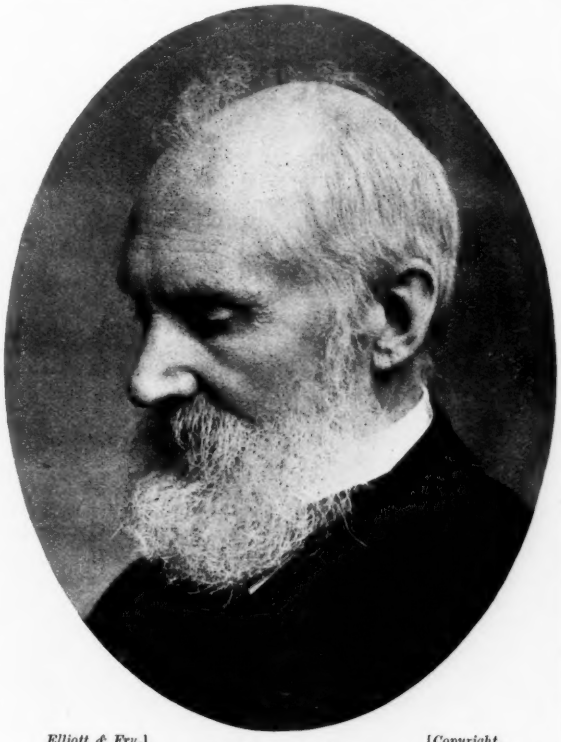
VOL. V. No. 1. [NEW SERIES.] JANUARY, 1908. [Entered at Stationers' Hall.] SIXPENCE NET.

CONTENTS—See page VII.

Lord Kelvin.

1824-1907.

THE deep regret with which we record the death of Lord Kelvin will be shared alike in Greater Britain, where Lord Kelvin's name was a household word, and throughout the whole world, where his achievements in science were almost as well-known as among his own race and people. A mere statement of the work he did,



Elliott & Fry.] [*Copyright.*

LORD KELVIN.

Born January 24, 1824. Died December 17, 1907.

such as may be found in the biographical indexes of his time, is testimony to the extraordinary range of his researches in pure and applied science; but the catalogue presents only one aspect, and that not the aspect of greatest importance, of his many-sided activity.

For more than a generation Lord Kelvin was the referee of mathematical physics. Of every new hypothesis, its author has asked: What will Kelvin think of it? When a tentative advance has been made his scientific colleagues have looked to Kelvin for criticism or consolidation, for advice, and for help. It has always been forthcoming. For more than half a century "Professor" William Thomson was a teacher at Glasgow University. For nearly as long a period he was the mentor, the collaborator, the scientific confidant of the long line of mathematical physicists, whose names, only less eminent than his own, fill the scientific annals of the latter half of the nineteenth century, and who are carrying on the tradition of great work in our own day. Among them are names like those of Tait, of Stokes, of J. J. Thomson, of Lodge, and of Rayleigh. He was eminent beyond the eminence of even these distinguished men, and few among his contemporaries or his immediate successors can hope to leave as many milestones on the road of research as he did in thermo-dynamics, in the physical nature of electricity, or the properties of matter. As a statement of Lord Kelvin's position and influence in science, the foregoing definition is nevertheless quite inadequate. It is inadequate, for one reason, because his creative energy was such that it continually diverted him into widely diverging spheres of research, and led him into the bye-paths of practical application. As another great mathematical physicist, Helmholtz, has said, the ability which was Kelvin's to translate mathematical equations into the physical realities is far more rare than the power to solve the problems of pure mathematics. We need not stop to inquire in which direction the greater service was rendered by Lord Kelvin to knowledge; it is necessary only to point out that, side by side with his definitions of the temperature of absolute zero, his solutions of electrostatic and electrodynamic problems; his theories on the physics of rotating spheres, and the age of the world, are a number of practical inventions of which his electrical instruments for use with minute electric currents were the first, and among which were such diverse inventions as a tide-predicting machine, a deep-sea sounding device, a compass, and a Kelvin tap.

His was an inventive genius that was an invaluable national asset to his country. If it were possible to express in figures the financial advantage which Lord Kelvin's discoveries conferred on Great Britain, what would be the limit that one could put on its capitalised value? But such a mind and such a personality are beyond estimate in any currency. One can say no more and no less of him than that his was a splendid intellect, an inspiring personality; and those who knew him best would add that his was also a magnificent character which with all its greatness was also as simple as endearing; and, as he was not afraid to let all men know, was imbued with a belief in the divine origin of all natural phenomena.

E. S. G.

XUM

A Southern Expedition.

By WALTER W. BRYANT.

ASTRONOMY has always laboured under the disadvantage that most of the work and a very large proportion of the equipment has been confined to the northern hemisphere. From time to time efforts, continuous or spasmodic, have been made to redress the balance, and among these may be cited the work of Lacaille, the expedition of Halley to St. Helena, the sojourn of Sir John Herschel at the Cape, and the foundation of the Cape Observatory to supplement the work at Greenwich. The long "exile" of B. A. Gould, in the Argentine, must not be overlooked in this connection, nor the foundation of the distant outpost of Harvard College Observatory, at Arequipa. A still more recent example was the work of Frank McClean, who, having completed a spectroscopic survey of the brighter stars visible in England, presented the Victoria telescope to the Cape Observatory, and himself completed his survey there for the stars out of reach in this country.

Attention is now being drawn to another excellent piece of work of a similar character, undertaken by the D. O. Mills expedition to the Southern Hemisphere, a brief account of which is intended in the present article.

It is now about eighteen years since the study of the velocity of stars in the line of sight, measured by the displacement of lines in the spectrum, bore striking fruit in the discovery of spectroscopic binaries. Soon after that time work on radial velocity with an improved spectrograph, was planned at the Lick Observatory, and for one great purpose among others, viz., the determination by spectroscopic methods of the sun's motion in space, Professor Campbell was convinced that no work there, however refined and elaborate, could give a satisfactory result without an extension of the investigation to southern stars.

In 1894 the first discussion took place as to the expediency and practicability of such an extension, but not until November, 1900, was any actual step taken, when a well-known wealthy American patron of science, Mr. D. O. Mills, was approached on the subject. Being already the donor of the Mills spectrograph, with which the Lick observations of radial velocity had been made, he undertook to defray the whole cost of the proposed expedition, including instruments, travelling, erection and maintenance, and the salaries of the staff.

As there was already available a three-foot silver-on-glass parabolic mirror, it was decided to equip the expedition with it mounted as a Cassegrain reflector, but as, owing to severe internal strains in the glass, it was smashed during an interval of the slow operation of cutting the central hole required for that form of mounting, a new mirror was cast with the hole in position, and work was pushed on so that the mounting and all parts might be tested together at the Lick Observatory in the summer of 1902, before starting for South America. But alas! the figuring was evidently wrong, the mirrors had to be returned for correction to Allegheny, leaving the mounting uncovered at Mount Hamilton, since, naturally, the dome had been sent direct to San Francisco, leaving also the leader of the expedition still waiting to start, and his successor at the Lick Observatory arriving with his family before his new abode was vacant. Also, of course, the summer was practically over, and the rainy season approaching. So the preliminary complete testing had perforce to be abandoned. The mirrors were completed by February, 1903, and the expedition reached Santiago, Chili, late in April, just at the beginning of the rainy season there; the precise time Professor Campbell had been all along scheming to avoid.

Professor Campbell's original intention to conduct the expedition himself had been frustrated by his appointment as Director of the Lick Observatory, but as the next best solution, W. H. Wright, who had for several years been working with the Professor at the Mills spectrograph, took his place, accompanied by H. K. Palmer as assistant. The landing at Valparaiso was accomplished under difficulties, owing to a strike accompanied by rioting, which coincided with the arrival of the expedition, but the mirrors and telescope, weighing about 900 pounds, were rowed gently ashore, balanced across the gunwales of a passenger boat. While waiting for the conclusion of the strike and the landing of the rest of the equipment, a month was spent in and around Santiago, prospecting for a favourable situation for the telescope, the site ultimately chosen being a hill at the end of a spur of the Cordilleras, called Cerro San Cristóbal, and rising about 1,000 feet from the plain. The Government of Chili and the municipal authorities of Santiago rendered hearty assistance to the expedition, including the services of a night policeman on the Observatory hill. The National Observatory offered the use of a brick-tower in the Observatory grounds, of just the size required, but on account of the great diurnal range of temperature there it was considered a very unfavourable site for a large reflector. Cerro San Cristóbal showed barely half as much diurnal range, and a mean annual night range of about 3° C., the difference being especially marked in summer. The hill was also nearly always well above the dust and haze of the city, and free from ground fog.

Towards the end of May the strike ended and the construction of the Mills Observatory was commenced. Observations began partially in September, on the completion of the buildings, but the electric line to the city was not finished until October, when the installation was at length complete.

Space will not permit a detailed description of the instrument itself, the devices for distributing the weight to prevent gravitational distortion, the driving clock and slow motions, and the prism train and spectrographic adjustments. But it is to be noted that considering the failure of the scheme of testing beforehand at Mount Hamilton, surprisingly few alterations were found necessary in the adjustments, and most of the special attention required was devoted to the question of temperature changes. Unfortunately, the large mirror was 40 per cent. thicker than had been intended, which allowed considerable variation of temperature within the glass itself, which alters the curvature, and consequently the focal length. As the value of the work done was strong testimony in favour of the importance of continuing it, no difficulty was found in persuading Mr. D. O. Mills to guarantee a further five years beyond the original estimate, and as soon as this decision was known, various improvements were ordered, including a galvanised-iron dome to replace the canvas-covered framework, which, though heavily painted, was not watertight, and improved driving ar-

rangements, besides a refrigerating device for keeping the large mirror from about sunset at the same temperature as it would naturally show during the greater part of the night, in order to avoid much of the temperature variation. The spectrograph itself was kept at a constant temperature by means of an electric current, operated by a thermostat.

It was found that the efficiency of the spectrograph was much affected by the state of the silvering of the large mirror, and in any case it appeared to be only about 50 per cent. of that of the Mills spectrograph on the 36-inch Lick refractor, so that longer exposures were necessary in Chili. This was partly due to the need for stopping down part of the beam through the base of the prisms, one of the small alterations referred to above. The actual ratio of the efficiency allowing for this is 64 per cent., but the lower altitude of the Chilian station, and the greater thickness of the lenses, and other differences in the spectrograph account for 16 per cent. deficiency, leaving 20 per cent. probably due to the low reflecting power of the mirrors. This, again, may be due to the impossibility of obtaining a fresh supply of purified chemicals, in consequence of the Chilian earthquake.

It seems probable that under the best conditions, the reflector should give equally good results as the refractor, but its susceptibility to temperature changes and especially the danger to the silver film of using it on a damp night, however clear, render its use more limited in duration than that of the refractor. This drawback, however, does not apply to general spectroscopic work, but only to radial velocity determinations with high dispersion spectrographs. By using two prisms, and occasionally a single one, instead of the three provided in the Mills instrument, much work can be done on nights when the full equipment cannot be used. In any case it must be borne in mind that the refractor cost 18 times as much as the reflector in the present comparison, and the building and accessories are almost in the same proportion.

There is no doubt that many of the difficulties can and will be smoothed away; for instance, by the provision of facilities for re-silvering the objective mirror with ease and certainty in cool weather.

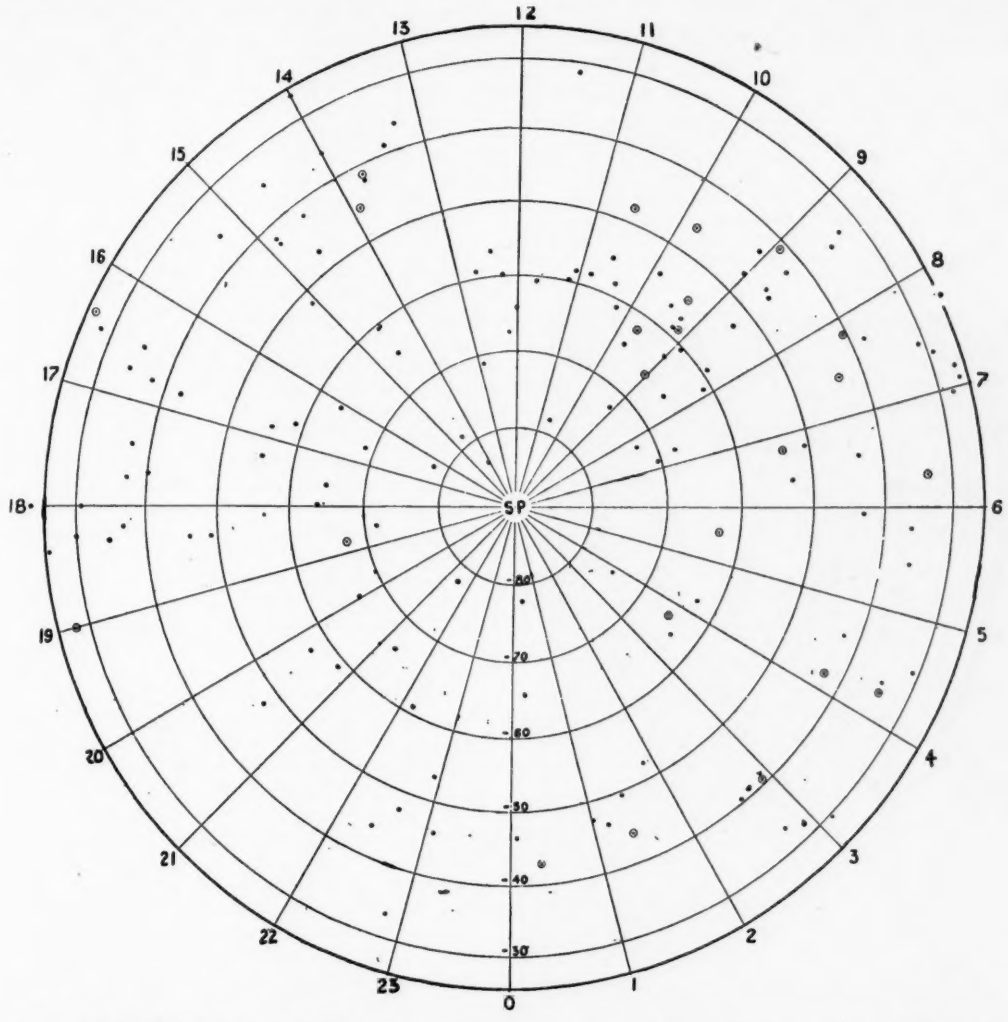


Chart showing Distribution of Stars Observed. Those with Variable Radial Velocity are "Ringed."

It will be noted that about two-sevenths of the sky is beyond the practical reach of Mount Hamilton. The accompanying chart shows the stars in this region observed by the expedition, variable velocity being indicated by a ring round the object.

Great interest awaits the publication of the complete results of the D.O. Mills expedition, especially in regard to the homogeneous determination of the solar apex, which has so long suffered from the lack of sufficiently accurate, complete, and homogeneous material.

Porpoises Playing at Stem of Vessel.

THE accompanying photograph is that of a group of porpoises swimming under water at the bow of a steamer travelling at the rate of 13 knots. The sea was perfectly calm at the time, and the photograph was obtained by leaning over the bows of the vessel and pointing the camera downwards. It will be seen that the stem of the vessel, as well as the bow wave, is included in the picture. The porpoises held their position in front of the boat with ease and without apparent effort or motion of body, tail, or fin, sometimes rolling right over sideways, but always keeping ahead of the ship. That they were not carried along by any body of water in front of the vessel was evident from the rush of air bubbles from their backs, and the white on their backs as seen in the photograph is due to that cause. The picture also shows that their skin is very much cut, and marked, and scratched, either from attacks or accidents. The animals retained their position in front of the boat for about half-an-hour. Calculated from the height of camera above water and the length of lens focus, the porpoises were about 8 to 10 feet long.

C. H. GALE.

Romano-British Flint Implements.

By W. A. DUTT.

THAT flint implements, other than the rough strike-a-lights, were in use in Britain at the time of the Roman occupation is a fairly well established fact. So long ago as 1869, the late General Pitt-Rivers, in the Journal of the Ethnological Society,* drew attention to the occurrence of such implements in association with Roman remains in Oxfordshire and the Isle of Thanet, and, as a result of investigations made by himself and others, he came to the conclusion that there was "good reason to suppose that flint weapons continued to be used by some of the inhabitants of this country even during the Roman era." Sir John Evans, too, in his "Ancient Stone Implements of Great Britain,"† mentions having found flint flakes at Reculver, St. Albans, and on other Roman sites; he also refers to like discoveries made by other archæologists. He suggests that many of these flakes were used in the production of fire; but that the worked flakes, by which the untrimmed ones were frequently accompanied, may have served as carpenters' tools for scraping, in the way that fragments of glass are used to-day. The employment of the flint-toothed *tribulum* (a primitive kind of threshing implement) in the neighbourhood of Roman villas would also, he adds, account for the presence of many flint flakes on the sites of the vanished villas.

A question that at once suggests itself is, how can flint flakes and implements of the Romano-British period be distinguished from ordinary Neolithic flakes and implements, by which, for present purposes, should be understood those flakes and implements belonging to the prehistoric period during which stone implements were used with or without implements of bronze, rather than to the Neolithic Age as a stage of culture? The fact of their occurrence on Roman sites certainly does not furnish a satisfactory answer to the question; for there is no doubt that many Roman camps and towns were established on sites previously occupied by prehistoric inhabitants of this country, and consequently the stone implements of the earlier settlers are often found intermingled with those of the Roman colonists or their native contemporaries.

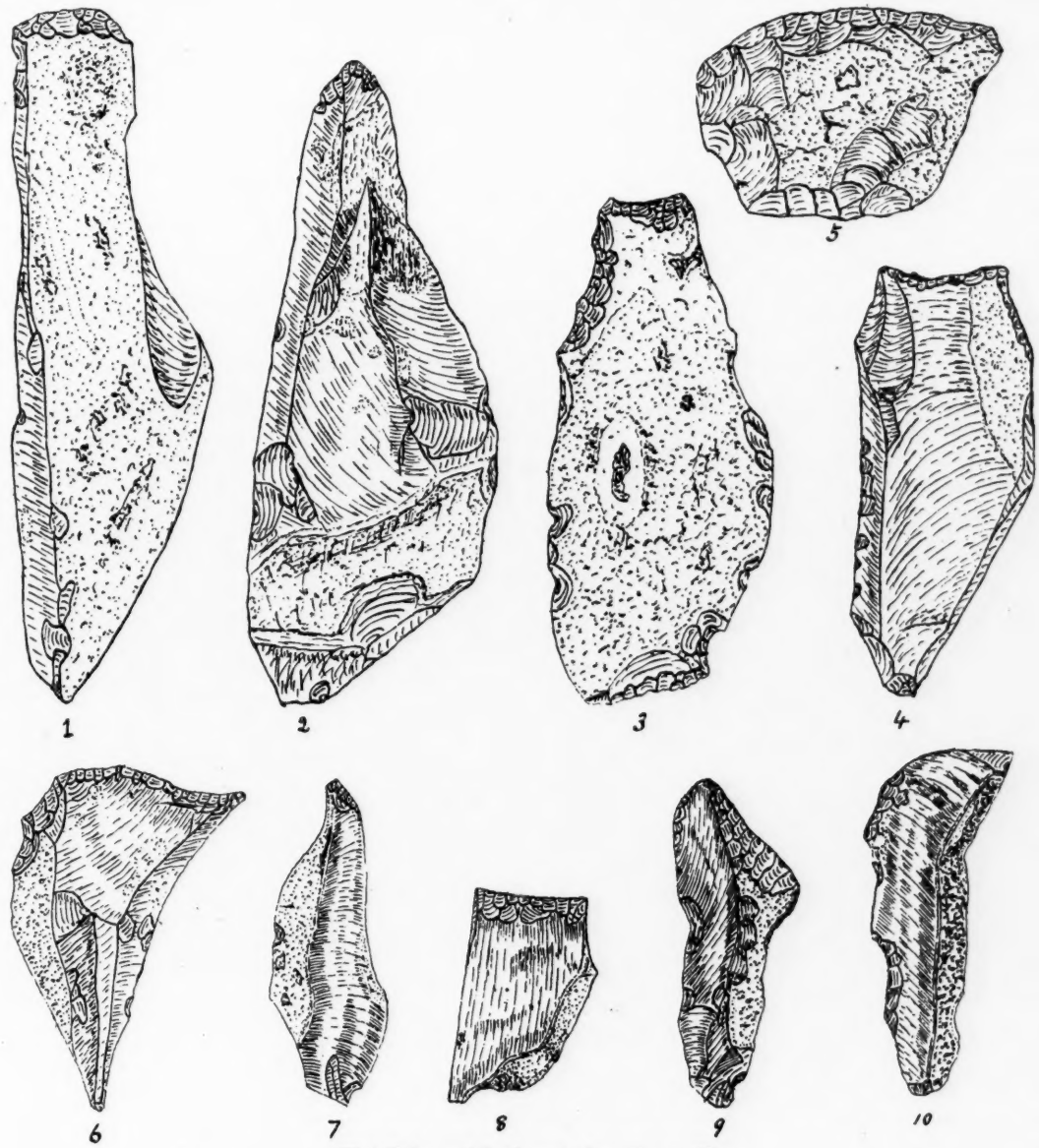
The difficulty exists mainly in consequence of the surface flint implements of this country having been considered as representing a stage of culture, few attempts having been made to distinguish the earliest surface implements from the latest, and to classify them according to their probable age. That the task is not an easy one may be readily admitted. In the case of Palæolithic implements, the archæologist has the aid of the geologist in determining their age; but the surface implements are found either on or just beneath the surface of the ground, where we are quite likelv to discover a modern Brandon-made strike-a-light or gun-flint lying side by side with a Neolithic arrow-head or a polished axe. When we know more about the "weathering" of fractured flint and the other changes it undergoes in consequence of being exposed or buried in certain situations, the task will probably be much simplified; but even now there should be little difficulty

* New series, Vol. I. p. 1, *ff.*

† Second edition, p. 283.

in deciding whether an implement found in a Roman camp is a Romano-British implement or an early Neolith.

In their valuable and instructive paper on "The Relative Ages of the Stone Implements of the Lower Thames Valley," *Messrs. M. A. C. Hinton and A. S. Kennard recognise two distinct groups of surface implements, the Cissbury implements, which are rudely fashioned, and nearly always weathered white, and the ordinary Neoliths, which include, among more roughly shaped tools and weapons, the delicately worked arrowheads, knives, and scrapers. In Norfolk, Mr. W. G. Clarke has found strong evidence of the surface stone implements of that county representing four distinct periods, though naturally there would be a certain amount of overlapping. In his "Classification of Norfolk Flint Implements,"* he divides the surface implements into (1) Early Neolithic or Cissbury Type; (2) Intermediate Neolithic or Boulder Clay type; (3) Late Neolithic or Sandy Site type; and (4) Polished implements of flint or other stone, or made of igneous or other rocks. With Mr. Clarke's reasons for believing that the implements of these four types represent different periods of the Later Stone Age, there



Flint Flakes and Implements from Roman Sites.

* *Proc. Geol. Assoc.*, Vol. XIX., p. 76 *et seq.*

* *Trans. Norfolk and Norwich Naturalists' Soc.*, Vol. VIII., p. 215 *et seq.*

XUM

is no need to deal here. For my present purpose, it will be sufficient to refer to his classification of the Norfolk implements of the prehistoric period, with the view of indicating how, in my opinion, flint implements of the Romano-British period can be distinguished from those of the Neolithic period.

The flakes and implements figured in illustration of this paper were all found by myself on sites well-known to have been occupied by the Roman colonists of East Anglia. Most of them were picked up within the walls of the great Roman camp (*Garianonum*) at Burgh Castle. When I picked them up I had no thought of their being anything but ordinary Neoliths, and it was not until they had been in my possession many months that a remark made to me by Mr. A. S. Kennard, to the effect that certain later implements were included among my Intermediate or Boulder Clay Neoliths, redirected my attention to them. I then essayed to pick out from among some hundreds of Neoliths, filling several boxes, those implements which appeared to me to be of comparatively recent date; these I set aside without attempting to decipher the locality names rather faintly inscribed upon them. Subsequently, on closely examining these selected flints, I was surprised to find that of 23 flakes and implements, 18 had come from the Roman camp at Burgh Castle, and 4 of the other 5 from other Roman sites.

No particular credit attaches to me for having made this curious and interesting selection; for in picking out the flints I simply choose those which had their facets quite lustreless. As they lay among the ordinary Neoliths, they had the appearance of spurious flint implements, such as a Brandon knapper can produce with a few blows of a flaking hammer and a few taps of a knapping tool; and when their secondary chipping was examined, its likeness to that of a modern gun-flint was very marked. The flaked portions of the implements were without the slightest sign of weathering; whether they were made of black flint or of grey flint, they were as dull as recently broken road metal. Yet strewn over the surface of the heavy land on which they were lying when I found them, there were scores of brightly-glazed flakes and implements. Had the former been as old as the latter they would have been just as bright.

While at Burgh Castle, in December, 1907, I extracted a score or more of the dull flakes and tools from the side of a recently excavated trench, where, at depths of from 1½ feet to 2½ feet from the surface of the ground, they were accompanied by numerous fragments of Romano-British pottery, also by many bones and teeth of horses, the presence of the last-named being probably due to the camp having been garrisoned by Stablesian Horse. In a neighbouring sand-pit, too, where a deposit of brick-earth was exposed, similar artificially-fractured flints were littered about with fragments of rude pottery. At Caistor St. Edmund, another Roman site, which is probably the *Venta Icenorum* of Antonine, the flint implements occurring within the enclosed area have, Mr. W. G. Clarke informs me, "a uniformly dull appearance"; whereas, in the rectangular camp at Tasburgh, which is now looked upon as being prehistoric, the chipped flints are as highly polished as those from the "breck" district of south-west Norfolk and north-west Suffolk.

So far as I am aware, there are no prehistoric flint implements in England to which these dull implements can be compared. That they bear no resemblance to the white-weathered Cissbury implements is obvious; nor is there any likeness between them and the beautiful chipped arrow-heads, knives, and scrapers of the East Anglian sandy sites. That they may have been in contemporary use with some of the finely-polished stone axes is possible; for such axes have been found in association with Roman relics, and, I believe, in Roman tumuli; but in the cases of the axes, the polish is the result of rubbing or grinding, and not of age. In form the implements from the Roman sites are not unlike some of the Intermediate Neolithic or Boulder Clay types; but these last-named implements are nearly always bright, some having a patination much like that of some Palæolithic flints.

Taking these facts into consideration, it would seem that these very dull implements found on Roman sites are later in date than even those beautifully-chipped implements which may belong to the Bronze or Early Iron Age. The evidence is in favour of their being Romano-British; but it is quite possible that some of them are of even more recent date—in fact, Anglo-Saxon.

DESCRIPTION OF FIGURED IMPLEMENTS, &c.

Fig. 1.—Chisel-like implement of chalk-crusted, dark-grey flint. Burgh Castle.

„ 2.—Implement of chalk-crusted, cherty flint, with trimmed point. Pakefield.

„ 3.—Chalk-crusted flake of dark-grey flint, worked at both ends, and with a worked hollow in one edge. Burgh Castle.

„ 4.—Ridged flake of dark-grey flint, trimmed at its broadest end, and along a portion of one side. Burgh Castle.

„ 5.—Scraper-like implement, made from an outer flake of a blackish flint pebble. Burgh St. Peter.

„ 6.—Borer or graver, made of a chalk-crusted, irregular fragment of dark-grey flint. Burgh Castle.

„ 7.—Chalk-crusted flake of grey flint, trimmed at the point. Burgh Castle.

„ 8.—Flake of chalk-crusted black flint, with sharp worked edge. Pakefield.

„ 9.—Thick ridged flake of chalk-crusted black flint, well worked on the right side of its thickest end. Apparently a side scraper. Burgh Castle.

„ 10.—Chalk-crusted flake of black flint, apparently trimmed for use as a knife. Burgh Castle.

It is interesting to note that most of the above implements, etc., appear to have been made from flakes struck off nodules of excavated flint, whereas Neolithic implements of the Intermediate type are made from flints derived directly or indirectly from the Chalky Boulder Clay. I do not know that the question of the origin of the flints, of which the Roman camp at Burgh Castle is built, has ever been gone into; but I have an idea that they must have come from the chalk near Norwich, and that the chalk-crusted implements found within the camp were made from some of these flints.

The Rotation of the Earth.

"IT must have struck all those who have been working in science, ever and anon, that when they fancied they had found something new, they find it was done by Sir Charles Wheatstone years ago."

This remark was made by William Spottiswoode at the Science Conferences at South Kensington in 1876, after a lecture by Professor W. G. Adams on Wheatstone's Acoustical discoveries.

Foucault's description of his famous pendulum experiment for demonstrating the rotation of the earth appeared in the "Comptes Rendus," February, 1851, vol. xxxii., pp. 135-138.

Wheatstone's "Note relating to M. Foucault's new mechanical proof of the rotation of the earth," in the Proceedings of the Royal Society, May 15, 1851, pp. 65-68, contained a description of an apparatus to exhibit the effects of the earth's rotation.

As no reference to this apparatus is made either by M. Blum ("Comptes Rendus," February 18, 1907, pp. 364-366) or in the description of his apparatus at p. 226 of the October issue of "KNOWLEDGE," perhaps the following may be of interest.

Wheatstone's apparatus (Fig. 1) consists of a graduated semi-circular arch, APB, of one or two feet radius (corresponding to a semi-meridian of the earth) which can be turned on a vertical axis. Central pull (corresponding to the force of gravity) is obtained by employing a spiral spring, CP, made of thin hardened brass wire coiled to a diameter of $\frac{1}{4}$ inch. By means of a sliding clamp, P, this spring can be set at any angle.

When the spring was vertical and was started by hand vibrating in any plane it kept on vibrating in that plane, however much the arch was turned on its

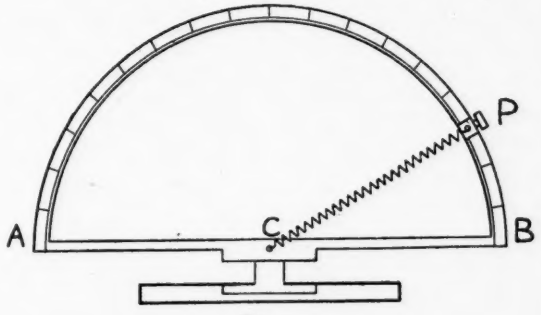


Fig. 1.

axis. When the angle, PCB, was 30° it was found that two revolutions of the arch were required for every revolution of the plane of vibration of the spring relatively to the arch.

In other positions of CP it was found that the number of revolutions of the arch required for every revolution of the plane of the spring relatively to the arch was equal to the reciprocal of the sine of the angle PCB. The original apparatus is, I believe, still preserved in the Museum of King's College, London.

In endeavouring to adapt Wheatstone's apparatus so as to conform more nearly in its outward configuration with the conditions of the real Foucault-pendulum experiment, the writer devised the following apparatus (Fig. 2) in August, 1905. It was described in the "Practical Teacher" of May, 1906, in an article written with the object of suggesting to science teachers a purely experimental method of investigating the behaviour of a Foucault pendulum at various latitudes.

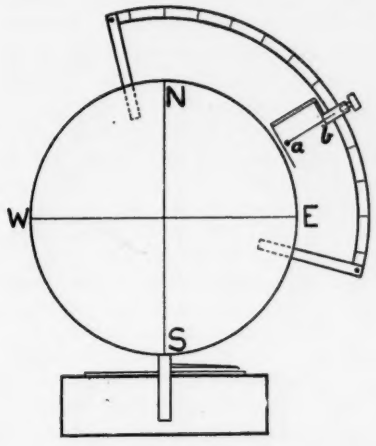


Fig. 2.

The apparatus consists of a globe, NESW (about 18 inches diameter), capable of rotation on its axis, NS, and a pendulum, *ab*, consisting of a piece of thin steel wire (about six inches long) of uniform circular section, with a small leaden bob. The upper end of the wire is soldered into a brass head, which can be securely clamped at any latitude, so that the pendulum when at rest at any latitude points to the centre of the globe. Divided circles are provided for observing the angles of rotation of the globe, and of the plane of the pendulum.

When the pendulum, at any latitude, θ, is set vibrating by hand in any particular plane and the globe then rotated through an angle α, the angle of rotation, β, of the plane of the pendulum can be observed with an accuracy sufficient to prove very effectively that

$$\beta = \alpha \sin \theta.$$

The methods of fixing the pendulum and its graduated circle were found, owing to want of rigidity, to damp to some extent the vibrations of the pendulum itself, and a wooden gibbet was shortly afterwards employed, the base of which could be secured at any latitude on the globe. The length of the pendulum was also increased so as to lengthen the time the pendulum would keep on vibrating.

With a pendulum 1 mm. diameter and 12 inches long, when the bob is started vibrating with a path three inches long, after 30 seconds have elapsed the path is still half an inch long, so that ample time is provided for taking observations of angles.

It will be seen that M. Blum's apparatus resembles the above very closely, though it is, perhaps, a little more complicated. DAVID BAXANDALL.

POPULAR LECTURE ON THE MOON.—Messrs. Newton are offering to amateur lecturers a series of sixty lantern slides of the moon, the photographs being designed to show successively the movements and phases of the moon, alike in relation to the sun and to the earth; and also, on a very complete scale, the natural features of the moon. Some forty photographs of the craters of the moon are embraced in the series, and the only alteration to the series that we can suggest is that the photograph of a terrestrial volcano, like Vesuvius, which is inserted for comparison with the lunar craters, should be replaced by some slides of the Hawaiian craters. Volcanoes like Vesuvius are comparatively rare on the moon.

XUM

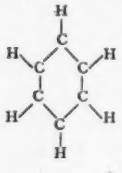
The Colour of Organic Compounds.

By PERCY MAY.

IT is well known that the colour of a body is due to partial absorption of the incident light. Thus a yellow substance is one which absorbs the violet and blue portion of the spectrum, and reflects or transmits the yellow region with part of the adjacent red and green. In the case of inorganic compounds this absorption is probably due to some vibration within one of the constituent atoms, for we find that most of the compounds of chromium, cobalt, trivalent iron, &c., are coloured. With organic compounds, on the other hand, colour must be a molecular rather than an atomic property, as we find that most compounds containing only carbon, hydrogen, oxygen, and nitrogen are colourless, while a fairly large number of such compounds are brilliantly coloured. The colour might be due to the size or the shape of the molecules, or to the mode of union of the atoms within them. Examination of a few facts will prove that the size of the molecules cannot be the cause of colour, for many very large and complex molecules, such as those of sugar, starch, amygdalin, &c., are colourless, whilst comparatively small ones, such as quinone, $C_6H_4O_2$, are coloured. On the other hand, most of the smaller molecules are colourless, as, for instance, alcohol, ether, and acetamide, while the majority of the dyes, both natural and artificial, are substances of great molecular complexity—*e.g.*, fluorescein, $C_{20}H_{12}O_5$, and indigo, $C_{16}H_{10}N_2O_2$.

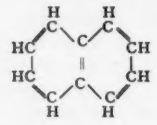
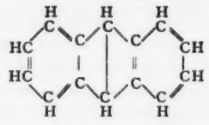
Very little is known of the shape of most molecules, but it is quite certain that no relation has been traced between this property and colour. Of late years, on the other hand, many theories have been proposed connecting the colour of organic compounds with the mode of linkage of the atoms within the molecule, and it is with these theories that we are concerned at present.

Most coloured compounds are derivatives of benzene, naphthalene, or anthracene, and therefore little could be known of their constitution before that of the parent substances was understood. It was in 1865 that Kekulé brought forward his well-known ring theory to express the constitution of benzene, and it is difficult to overestimate the importance of this conception. According to this view, the six carbon items are united in a ring :—



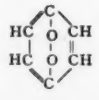
Kekulé represented the fourth valency of the carbon as being satisfied by alternate "double-bonds" , but these do not represent the same state of affairs as in ethylene compounds. Variations of this structure are those of Claus , and Baeyer , but perhaps the most satisfactory is the modification of the Kekulé formula where the "double-bonds" are represented as continually revolving round the molecule,

Similarly, naphthalene and anthracene are represented by the formulæ

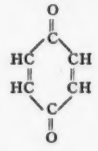
 and 

respectively.

The simplest coloured organic compound is quinone, $C_6H_4O_2$, and two constitutions have been devised to account for its behaviour : The peroxide formula of Graebe and the ketonic formula of Fittig. It seems likely that

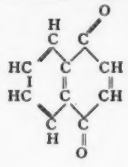


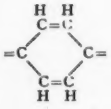
GRAEBE.

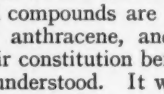


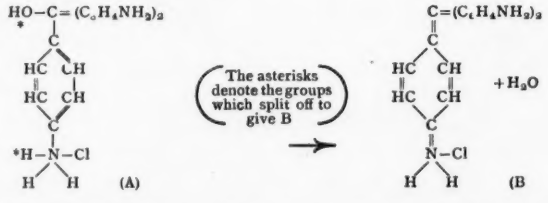
FITTIG.

quinone may be capable of existing in both forms (*i.e.*, to exhibit the property of tautomerism), but the latter formula is usually chosen to represent its constitution. Not only is quinone bright yellow, but many bodies of the same class such as α naphthoquinone are also yellow, and for this reason, in 1888, Nietzski, in Germany, and Armstrong, in this country, advocated a "quinonoid" structure

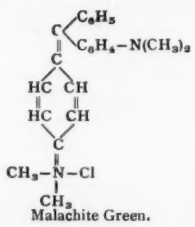




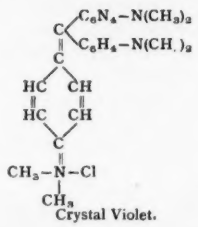
for coloured compounds. The study of a few characteristic examples will give an idea of the scope of this theory. The colour base of pararosaniline is  and is colourless ; this forms a salt by the addition of one molecule of HCl, which has the formula



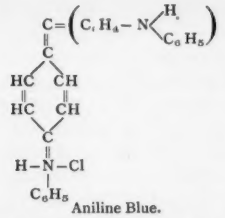
This salt is very unstable and cannot be isolated as it readily loses one molecule of H_2O, giving the brilliant magenta dye (B). In a similar way other dyes derived from $HO{\cdot}C = (C_6N_5)_3$ are salts formed with elimination of water, and may be given a quinonoid structure :—*e.g.*,



Malachite Green.



Crystal Violet.



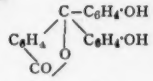
Aniline Blue.

Another set of brilliantly-coloured substances is formed by the azo-compounds, many of which are commercially used as dyes. As an example, we may take amidoazobenzene (aniline yellow). The formula usually given for it is $C_6H_5-N=N-C_6H_4-NH_2$, but its behaviour is just as well expressed by the formula

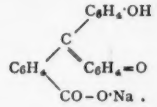
$$C_6H_5-NH-N=C_6H_4=NH,$$

where we again have the quinonoid structure.

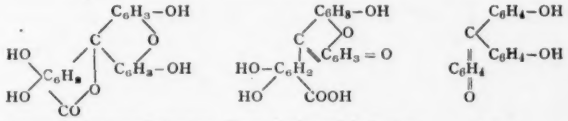
It is a well-known fact that phenolphthalein is colourless in neutral or acid solution, but becomes intensely coloured with a trace of alkali. This is accounted for by by the fact that the substance itself is not a true acid but has a lactone formula



while in the coloured salt the lactone ring is opened out, giving a quinonoid structure :—



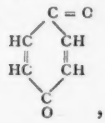
Similarly for the fluoresceins the formulæ are :—



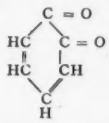
Type of colourless derivative — Type of coloured derivative — Aurine

Fluorescein

Besides ordinary quinone in which the two oxygen atoms are united to carbon atoms in the *para* position



there has recently been discovered an isomeric substance in which the CO groups are in the *ortho* position



The colour of this substance is red instead of yellow, and this is quite a general rule the paraquinones being yellow and the orthoquinones red.

α naphthoquinone yellow. β naphthoquinone red.

Although the consideration of orthoquinones extends the usefulness of the theory of quinonoid structure, yet there are many instances where it cannot be applied. For example, the brilliant yellow colour of meta-nitraniline

cannot be accounted for by the usual theory of quinonoid structure. Another weakness of the quinonoid theory in its original form is that it does not attempt to explain *why* quinonoid bodies should be coloured.

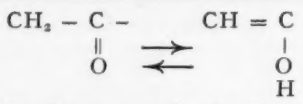
Before attempting to answer this question, mention should be made of Witt's theory of chromophores, and other similar theories, according to which colour is due to certain chromophoric groups, such as :—

(1) $-CO-C=C-C=C$
(2) $-CO-CO-C=C-$
(3) $-C=C-CO-C=C-$
(4) $-CO-C=C-CO-$

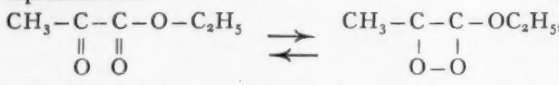
It should be noticed that (1) and (2) contain the same groupings as the orthoquinones, and that (3) and (4) have the same groupings as in paraquinones. Witt, from his investigations of nitrogen compounds, has proposed other "chromphores" to account for their colour. Thus, toluylene blue $N(CH_3)_2-C_6H_4-N=CH-C_6H_3(NH_2)_2$ contains the chromophore $-N=\overset{H}{\underset{|}{C}}-$ which Witt regards as a link between that of rosaniline $-NH-C=$, and that of the azo series $-N=N-$. This theory is simply useful to co-ordinate a number of facts, and it does not appear to be very fertile or helpful when compared with the other theories of colour.

So long as attention was paid only to considering whether a substance was coloured or not, little progress could be made, as the subject was necessarily of a qualitative and empirical nature. The application of spectroscopy furnishes the quantitative basis necessary to raise the study of the origin of colour to the level of an exact science, and the results obtained tend to explain the true physical meaning underlying the theory of quinonoid structure. Hartley was the chief pioneer in the study of the ultraviolet absorption spectra of organic compounds, and he has discovered certain most important facts connecting chemical constitution and absorption spectra. The method employed by Hartley was to measure the absorption limits at a great many concentrations, always gradually increasing the dilution until complete transmission was obtained. The oscillation frequencies of the edges of the regions of absorption were then plotted against the corresponding strengths of solution, and a curve drawn through the points so obtained. It is the shape of these curves that has been connected with the chemical constitution of the substances.

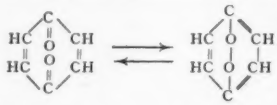
Recently much work has been done in this direction by Baly and others, and they have obtained results of very great interest, but it is impossible to describe them fully without too much technical detail. A clear account of these very ingenious theories is given in the Transactions of the Chemical Society, Vol. 89 (1906), and in the Astrophysical Journal, Vol. 24, but we will here endeavour to give an outline of their general idea. Many substances containing the group $-CH_2-CO-$ have for some time—on purely chemical grounds—been supposed to exist in the form $-CH=C(OH)-$, and to this phenomenon the name tautomerism has been given. Substances of this kind give an absorption in the ultraviolet, and Baly and Desch suppose that this is due, not to the actual wandering of the H atom, but to the change of linkage (*i.e.*, the breaking of the bonds between the atoms) in the process of tautomerism



It was also found from a study of substances containing two adjacent carbonyl (CO) groupings, that in those cases the position of the absorption band was shifted towards the red, with the production therefore of colour. In the case of pyruvic ester, the inter-atomic disturbance can be represented as



and Baly and Stewart propose the term isorropesis to denote this finer play of forces between two carbonyl groups. The theory of isorropesis will give an explanation of the cause of colour in quinonoid bodies, for isorropesis can occur between the residual affinities of the oxygen atoms, which results in the absorption of light in the visible region of the spectrum. These results are not antagonistic



to the ordinary theory of quinonoid structure, but on the contrary they supply the key to it, and indicate why quinonoid bodies should be coloured.

It has been previously stated that the ordinary theories do not offer any explanation of the colour of compounds such as metanitraniline, but by consideration of the modern vibration theory of the constitution of benzene, Baly, Edwards, and Stewart have ingenously extended the theory of isorropesis to include meta-quinones. It is impossible to reproduce their arguments without too great technical detail, but those interested in the subject will find an account of them in the Journal of the Chemical Society (Transactions), Vol. 89.

Until recently, the theory of isorropesis was able to account for practically every case of colour due to the linkage of the atoms, but now some facts have been brought to light which cannot be explained by its aid, and necessitate a new development of the subject. Thus, nitrodimethylquinol is said to be bright yellow, and its colour cannot be accounted for by any existing theory. Much therefore still remains to be done, but there can be no doubt that spectroscopic methods have thrown much light on chemical constitution where purely chemical methods have failed. Certainly, a study of colour theories, past and present, will convince one of the truth of Hartley's statement that "by the systematic study of absorption spectra, can we alone obtain the necessary accumulation of facts which may enable us to arrive at a just conclusion as to the origin of colour."

Solid Telescopes.

THE City and Guilds of London Technical Institute has recently dealt with a problem which may have many useful applications. It is called, in brief, the construction of solid telescopes, and may be described as follows:—

When a telescope is employed to regulate and adjust the direction of any machine or apparatus, as, for instance, in a gun-sight, or when it is employed by its own motion to furnish angles with accuracy, as in altitude or declination instruments, spectrometers, etc., it is a *sine quâ non* that its own line of collimation, and the means of indicating it, should remain fixed in reference to the structure which carries it.

The object-glass of a telescope is composed of a combination of lenses, placed, perhaps, in contact, but for optical reasons not too tightly secured in position by the screw of the cell which contains them. The lines of the field, whether drawn upon glass or consisting of fine wires, are supported in a frame, itself held in position by adjusting screws.

Thus, there is considerable chance of motion of an undesirable character taking place with instruments requiring to be continually taken down and put up again, as theodolites and levels, or which are necessarily subject to shocks, as gun-sights.

The idea at the bottom of the course pursued in the investigation is to get over these difficulties by the adoption of two measures, viz., (1) Cementing the lenses of the objective at surfaces having a common curvature, and (2) prolonging the glass of the second lens up to the principal focus, and terminating it there in a plane face, upon which is engraved any scheme of lines suitable to the purposes of the telescope.

It will be at once understood that with such a special arrangement, the rules of more ordinary construction have to be greatly modified. The conditions of the second lens are constrained at one end by its having to fit the first lens exactly, and at the other end by its plane character.

As, therefore, there are only two curvatures in this part of the system, it is clear that success must depend very largely upon the choice of glasses, but the results of the designed instrument show that with appropriate glasses selected from modern lists, the important aberrations may be reduced to a point much below significance, and the constructed instrument shows that the design may be sufficiently nearly approached by a skilful maker to fulfil these practical requirements. The Technical Institute will furnish upon application information of a complete character as to the glasses and other details of the design.

Solar Disturbances During November, 1907.

IN presenting this report for the first time, it is necessary to give just a word of explanation. The chart is constructed from the combined observations of Messrs. John McHarg (Lisburn), A. A. Buss (Ashton-on-Mersey), and F. C. Dennett (Hackney). The numbers along the top of the chart give the day of the month, and indicate the longitude of the central meridian at noon on the day shown; that of November 1 being 84° 15′.

No. 178.—An October disturbance, only a spot on November 1, when last seen.

No. 180.—An October disturbance, the remains of an elliptical group. 27th to 4th.

No. 181.—An elliptical group of pores, October 31, a line of pores November 4, a spotlet and pore on 5th, when last seen.

No. 182.—A pair of spotlets 4th to 12th, one increasing to 9,000m. in diameter.

No. 182*a*.—A line of pores with a maximum length of 5°.5 on the 5th. 4th to 6th.

No. 182*b*.—A pair of pores 5th to 8th.

No. 182*c*.—A spotlet grew to 14,000m. in diameter; 4th to 15th; the active group of pores behind, 5th to 13th. The faculic area dotted, first seen 11th and 12th, with a bright knot, long., 349°, 16° S. lat., is of special interest because from it, when on the limb on 15th, Dr. A. A. Rambaut saw the great outburst attaining the height of 324,600 miles above the solar surface. The position angle of the eruption was 273°, corresponding to about latitude 16° S.

No. 183.—A constantly varying group of pores, occupying a considerable area, seen 5th to 12th.

No. 184.—Group of 5 pores just breaking out, in bright faculæ close to the area where 180 died out, on 5th and 6th.

No. 185.—Spots and pores, broke out on 8th, and by 10th formed a group 60,000 miles in length, later taking on elliptical form, very active. The largest spot, 14,000 miles in diameter, seen until 15th.

No. 186.—Pores from 8th to 10th.

No. 187.—The return of a group first seen September 17, under observation in November from 8th to 21st. On 11th a great part was involved in one penumbra. Including *a*, the group measured 110,000 by 70,000 miles, one member 40,000, and another 30,000 miles in diameter. Visible to naked eye.

No. 188.—Spot 10,000 miles across, seen 10th to 20th, and a companion pore *a*, 12th and 13th.

No. 189.—A pore seen 12th and 13th.

No. 190.—A spot and pore seen 17th to 23rd, *following* 188.

No. 191.—First pores, then a spotlet and two pores, seen 19th to 25th.

No. 192.—Four pores only seen 20th; on 24th *a*, a rapidly changing group of two pores and one spotlet seen, but not after.

No. 193.—Return of 181, died out after 23rd, but revived for the day on 25th, 20th to 25th.

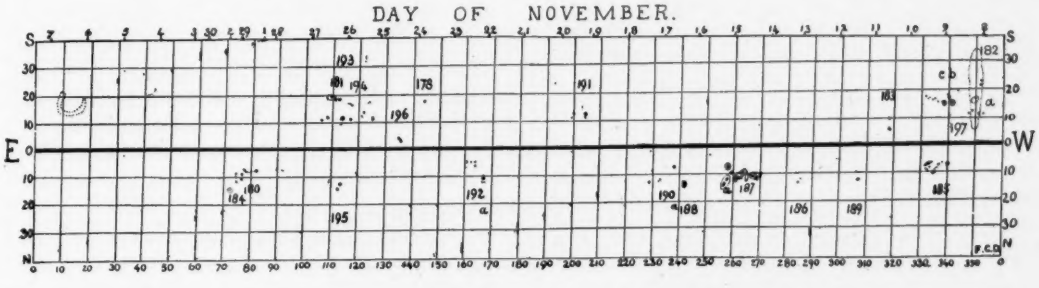
No. 194.—A double group 21st to 28th; 21st 17° long., 22nd and 23rd, 20°, *p* portion then died out. One spotlet 7,000 miles in diameter.

No. 195.—A pair of pores 24th to 27th.

No. 196.—A pair of pores 28th to 30th.

No. 197.—Return of 182*c*, accompanied by pores, 18,000m. in diameter, 30th until December 11. On the return of 197 and 193 it will be noted that the longitude is rather greater than at their former apparition, brought about by the slower rotation of the photosphere as the higher latitudes are reached.

The great horseshoe-formed faculæ, longtitude 8° to 18°, seen November 28 to 30, is an instance of partial or complete elliptical rings seen from time to time.



CORRESPONDENCE.

To the Editors of "KNOWLEDGE AND SCIENTIFIC NEWS."

SIRS,—Professor Marmol, referring to my article in your July number, appears to think I consider Alcyone (or the Pleiades group) to be the centre round which our sun revolves. I was careful, however, to point out that I regard the evidence altogether insufficient to show this, but that it is *highly probable* that Alcyone is physically as well as optically the central sun of *a* system, and that we have evidence of the existence of bodies of magnitude as much exceeding that of our own sun as the latter exceeds its planets. Sirius, Canopus, Arcturus, and β Centauri must all of them be much greater than the sun.

With regard to the probable velocity of our system no doubt Struve's value is as good as any, but it was well shown by the late Mr. Proctor, formerly editor of "KNOWLEDGE" (whose careful work is too little known), that from our vague knowledge as to the true distances of even the nearest stars all such estimates are premature. However, granting such value for the solar velocity, it is, to say the least, a stretch of imagination to assume that this is all due to one attracting centre, and thus calculate what the mass of that centre may be for various distances.

Acceleration is *rate of change of velocity* and not velocity itself. The direction of solar velocity is known only approximately. I was myself taken to task for saying this was towards Hercules rather than towards Lyra, yet, after all, it seems astonishing we can know even so much. Still, whilst we barely know more than the mere fact of the direction and approximate magnitude of the sun's velocity in space, it seems altogether hopeless to speculate as to the *rate of change* of this quantity which (and *not* the velocity itself) is the measure of the acceleration acting upon it. (The velocity of a falling body may be anything greater than zero, but this velocity *increasing* at the rate of 32 feet per second, the acceleration due to the earth's attraction upon it, has the value 32): $F = ma$, or $\frac{F}{A} = m$. No acceleration, however, is required in the case of a body moving in a straight line with uniform velocity (Newton, Law I.). It must be many years before we can hope to estimate the total amount of the acceleration experienced by our sun from the other bodies in the Universe.

Yours, etc.,

London, S.W. F. W. HENKEL, B.A., F.R.A.S.

THE VITASCOPE.—From Messrs. Newton we have received an ingenious instrument called by them "The Vitascope," which is designed to enable an observer to examine microscopically small living objects under natural conditions and amid their customary surroundings. With the ordinary microscope, the object under examination has to be placed with a strong light on the instrument, and the lenses have to be very close to it, so that the conditions are unnatural, and one can only observe the movements of a living creature which is under restraint, and probably terrified. With the "Vitascope," on the other hand, the observer may stand as far as 3 feet away from the object, or at any less distance, until the object-glass of the "Vitascope" is about 5 inches from it, while the ordinary daylight suffices for the examination, and the object need not be touched or moved from its place. The advantages for the purpose of Nature study are too evident to need recapitulation.

XUM

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Carbograph. A carbon tissue of a sensitiveness comparable to that of bromide paper, so that direct carbon enlargements may be made by artificial light, offers distinct advantages. Like so many other things, it may have been possible for a long time, but it has remained for the Rotary Photographic Company to elaborate a method of preparing such tissues in large quantities. It is quite true that, by the "ozobrome" process, one may prepare a bromide enlargement, and then either convert it into a carbon print or prepare carbon prints from it without employing light, the metallic silver of the enlargement acting directly or indirectly as the reducer of the bichromate; but the tissue used in the "Carbograph" process is complete in itself, it contains both the silver bromide to confer the sensitiveness and the pigment for the print. To use the tissue, it is exposed as if it were simple bromide paper of a rather slow kind, developed with ferrous oxalate or ferrous citrate, as ordinary alkaline developers might interfere with the solubility of the gelatine and so upset the subsequent process, and cleared in a weak acid bath as is usual after iron development. After rinsing in three or four changes of water, the print is immersed for three minutes in a solution of potassium bichromate that contains a little alum, and then washed. The print is now ready for mounting on transfer paper, and developing in warm water exactly like an ordinary carbon print that has just been exposed. The gelatine that forms the resulting picture will contain, in addition to the pigment, the metallic silver of the first developed image and silver bromide. An ordinary hypo. bath removes the last, and if it is desired to get rid also of the metallic silver, potassium ferricyanide is added to the hypo. in the ordinary manner.

The metallic silver produced by the first development effects the reduction of the bichromate in its immediate vicinity when the print is put into the bichromate bath, and the resulting chromic compound renders the gelatine insoluble. It is stated that the silver itself remains as such, not being oxidised as might have been supposed, and that it reduces the chromate by mere contact action. In the ozobrome process, in which a silver image also reduces the bichromate, the silver itself is undoubtedly converted into a salt, but the solution used in this case contains a ferricyanide and a bromide as well as the bichromate. There is also the further difference, that in the ozobrome process the pigmented and sensitised gelatine is in one film and the silver image in another and these two films are simply brought into contact face to face, while in the new "Carbograph" paper, the silver image and the pigment are intimately mixed in the same film. It would be interesting to examine the chemistry of each of these methods of work in the light of the other. But whatever the changes may be found to be will not affect the fact that the photographer has now at his disposal more ways than one by which he can prepare quite satisfactory carbon prints without the need for that most uncertain, and often rare agent, daylight, a little extra manipulation taking its place.

There is one matter in particular that merits attention with reference to the new "Carbograph" paper. It is, as stated, possible to leave the silver image with the pigment image, and this silver may be acted on for intensification or toning purposes in any of the ways that ordinary bromide prints may be treated, provided only that nothing is used that will act detrimentally upon the colouring matter, which is often a mixture, that forms the "pigment" image. Such a picture is not a "carbon" or "pigment" print, nor a "silver" print, it is a hybrid, and if such things are made they should have a new name. Obviously, they must suffer from the uncertainty that is inherent in all silver prints, and cannot possess the chief recommendation of a genuine carbon print, namely, its stability. The importance of removing all the silver should, I think, be emphatically urged, then the colour of the pigment will be obtained in its purity, and the result may be properly called a "carbon" print.

The Continuing Action of Light. In *Science Abstracts*, number 1,499, is a short account of a paper by P. Villard, describing how prints on albuminised or salted paper exposed only sufficiently to just show the darkest parts, if removed from under the negative and exposed to sunshine under green or yellow glass, which cuts off the blue and ultra-violet, will come up in about ten hours with all their details and clear in the high lights. The result is not the same as longer exposure under the negative would give, but shows greatly increased contrasts—the effect of under exposure and intensification. A soluble salt of silver is necessary for the continuation effect. A dry gelatino-chloride plate may have an exposure effect that has been produced upon it undone by exposure to red and infra-red light, and it is thus possible in spectro-photography for this part of the spectrum to have its effect balanced and neutralised by stray light.

Stand Development. The use of an abnormally diluted developer for a proportionately long time is supposed by some to be an especially advantageous method of work. Like all methods, it has its good points and its weak points. Messrs. Wratten and Wainwright, in a four-page pamphlet that they have just issued, lay special stress on its shortcomings. They find that rodinal used in this way is so much affected by the air dissolved in the water with which it is diluted, that it always requires a longer time than is proportional to its dilution, and how much longer depends on the character of the water. Metol and metol-hydroquinone present similar difficulties. Pyro-soda also needs an unduly long time as compared with its dilution, but the increase is the same whether the water be as nearly air-free as possible, distilled, or drawn from the domestic tap. Glycin, however, furnishes a developer that gives the same result whatever water and how much of it is used, by simply increasing the time in proportion to the dilution. The unevenness of development, due to the plates being too close together or too near the bottom of the tank, and other possible troubles are referred to.

Received. Messrs. J. H. Dallmeyer send a list of their specialities and booklets that clearly indicate by examples exactly what their well-known telephoto. lenses will do when used in connection with the apparatus that photographers generally employ. In the ordinary list of lenses it is interesting to note that the old "triple achromatic lens," that many would regard as obsolete, is described as "the first anastigmat ever made," and is stated to retain its popularity. The company draw special attention to the "Packard-Ideal" shutters, behind lens shutters that work noiselessly and are particularly suitable for studio work.

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Bright Knots on Saturn's Rings.

THE observations of Saturn during November resulted in the detection of several interesting novelties, which, if found to be true, may have far-reaching consequences on the constitution of the planet's system. The original message from Professor Lowell, of the Flagstaff Observatory, reads as follows :—

"Condensations in Saturn's rings confirmed here and measured repeatedly. They are visible, symmetric, and permanent. Outer situated near the outer edge, ansa *b*, and inner at middle of ansa *c*. A conspicuous relative gap also detected and measured at 1.56 radius from the centre of the planet. Ring easily seen. Placed further south from shadow at west than at east." A later telegram read: "Ring shadow on Saturn bisected, black medial line; phenomenon explicable by extra-plane particles only."

If these observations indicate real aggregations of the ring material, it appears that we have here a unique opportunity of studying the results of interactions or, possibly, collisions between celestial bodies, both physical and constitutional. If the spectrum of these condensations be photographed by anyone possessing the necessary instruments and favoured with a fine sky, the result of collisions, and, therefore, presumably, vaporisation of part of the materials, would be indicated by the presence of bright radiation lines superposed on the Fraunhofer spectrum due to reflected sunlight, or if the amount of vapour be sufficient, we might find absorption lines of increased intensity at the corresponding positions.

Spectroscopic Observations of the Sun's Rotation.

Working at the Solar Observatory on Mount Wilson, California, Mr. W. S. Adams has been engaged since the summer of 1906 in obtaining photographic records of the rotational velocity of the sun in various latitudes. The work has been done with the Snow telescope, which gives an image of the sun 6.7 inches (17.0 cm.) in diameter on the slit plate of a powerful Littrow grating spectrograph, the scale being 1 mm. = 0.71 Angstrom unit at λ 4200. To bring the opposite limbs of the sun together for comparison of their spectra, the author used a pair of small diagonal prisms on each of two rotating arms, the centre of rotation coinciding with the centre of the slit. One of the prisms is placed at such a distance from the centre as to correspond to the mean radius of the sun's image, and it is capable of adjustment to allow for the varying size of the image during the year. The second prism receives the rays from the first, and then directs them through the slit of the spectrograph. When the two sets of prisms are in adjustment we shall thus have in the spectrograph the spectrum of two parts of the sun's limb along a diameter. By rotating the brass frame carrying all four prisms it is thus possible to compare all the opposite pairs of points on the sun's limb from pole to equator.

The region of the spectrum found most suitable for the investigation was from λ 4190 to λ 4300, in which certain lines of lanthanum, carbon, chromium, zirconium, iron, manganese, nickel, and titanium were selected for measurement. Forty-four plates were obtained, and tables giving detailed values of the velocities determined for each line and degree of latitude.

There are striking differences of rotation given by the various lines. Thus the two lines due to carbon at λ 4197.26 and λ 4216.14, and the lanthanum line at λ 4196.70, show systematically low values of the angular velocity, which, in the lower latitudes, amounts to about 0°.1 in the daily rate, which would mean about *four hours* in the equatorial period of rotation. It is interesting to note that for both of these elements we have independent evidence that they lie at a low level in the sun's atmosphere. In the opposite sense the lines of manganese at λ 4257.82 and λ 4266.08 give large rotational velocities. So far these results are in agreement with those of Jewell, who found the lower portions of the solar atmosphere to have the longer rotation period. As a useful comparison with the rotation values which may be determined from spot, faculæ, or flocculi positions, the following table is given showing the daily angular rotations for each 10° of solar latitude.

Latitude.	Angular Rotation.	Period in Days.
°		
0	14·72	24·46
10	14·52	24·79
20	14·13	25·48
30	13·62	26·43
40	13·03	27·63
50	12·53	28·73
60	12·15	29·63
70	11·90	30·25
80	11·70	30·56

It is seen that the rate of change of the rotational velocity with latitude is greatest at about lat. 30°. It becomes less in higher latitudes, and beyond 70° is very slight. There is no evidence of appreciable variation in the rate of rotation during the fourteen months covered by these observations.—(*Astrophysical Journal*, 26, p. 203, November, 1907.)

Constancy of Wave-Length of Spectral Lines.

An important statement has recently been made by Professor Kayser with regard to the question whether the wave-lengths of spectral lines are invariable, or whether they depend on the mode of production of the spectrum, whether the density of the vapour has any effect, &c. The matter is of the greatest consequence in the interpretation of both terrestrial and celestial spectroscopic evidence of constitution, and as the results of Professor Kayser's own work are taken as standards for many branches of research, his views on the subject are of special interest. To take one case in particular, Exner and Haschek have recently published a paper (*Sitzung der Wiener Akad.*, 116, IIa, pp. 323-341, 1907) in which they seek to adduce evidence for changes of wave-length, based on measurements of the Lanthanum spectrum made in Professor Kayser's laboratory. Instead of thus regarding the differences, which undoubtedly exist, Professor Kayser ascribes them to the existing errors in the standards employed. In this case different lines were used, thus adding to the possible error. It was with the hope of remedying such errors that the International Solar Union arranged for the more precise determination of certain standard lines by means of interferometer measurements.

Apart from this indirect evidence, there is now available direct proof of the constancy of wave-lengths over very extended conditions of physical state. At the meeting of the Solar Union at Meudon in May, Professor Ames announced that Dr. Pfund had made experiments with the interferometer which proved that the wave-lengths were precisely the same, regardless of whether the spectrum was produced in the spark or in the arc, at atmospheric pressure or in a vacuum, of pure metals or of an alloy or salts. Professor Fabry also said that his experiments had yielded precisely the same result. The pseudo-variability produced by selective variation of the components of multiple lines has, of course, been recognised for many years, and does not affect the present discussion.—(*Astrophysical Journal*, 26, p. 191, October, 1907.)

Occurrence of Sulphur in the Hotter Stars.

Until last year we have had no certain evidence of the presence of sulphur in the spectra of stars, but in a paper recently read by Sir Norman Lockyer before the Royal Society it is announced that several lines of the spectrum of this element have been detected in a photograph of the spectrum of Rigel (β Orionis). The sulphur was first de-

XUM

tected by means of the sulphur line at λ 4815.3, but later the other sulphur lines between λ 4142 and λ 4175 were also found in the Rigel spectrum. Photographs of the sulphur arc and spark spectra were obtained in the laboratory for confirmation.

No traces of these sulphur lines have yet been traced in the spectra of γ Cygni and Sirius, which are slightly lower on the temperature classification scale, but they are present in the slightly hotter star Bellatrix (γ Orionis), but not so strongly marked as in Rigel.

Two abnormal lines in the sulphur spectrum, at wavelengths 4253.8 and 4285.1, are not found in the Rigel spectrum, but are found in the spectra of hotter stars, such as γ, ε, and κ Orionis. Pickering also records these lines in β Centauri and α Pavonis. Laboratory work on spark spectra shows that these two special lines of sulphur *decrease in intensity* relatively to the diffused sulphur lines, when self-induction is introduced into the secondary circuit of the coil, thus suggesting that they are high temperature lines, and thereby providing another exceedingly valuable searching test for stellar classification, such as is already known in the behaviour of the various groups of silicon lines in other stars.—(*Proceedings Royal Society, London*, vol. 80, p. 50, December, 1907.)

Solar Prominences of 1906.

Professor Ricco gives in his annual summary of prominence activity for 1906 the numbers of prominences seen in 100 zones of latitude, showing that the principal maximum occurred in latitudes near ± 20° to ± 30°, as in 1905, while the secondary maximum was from ± 70° to ± 80°, being thus some 10 degrees higher than in 1905. Excepting during the last quarter of the year, the number of prominences observed in the northern hemisphere was greater than in the southern, the numbers being 284 and 185 respectively.

The mean daily frequency for the year was 2.7, and the mean height 44″.2.—(*Mem. del Soc. degli Spettroscopisti Italiani*, vol. 36, 1907.)

BOTANY.

By G. MASSEE.

Self-pruning of Trees.

THE fact that natural pruning occurs has long been known. The subject has been studied by Mr. C. Stuart Gager, who has a note on the subject in the *Journ. New York Bot. Garden*. Natural pruning means the loss of certain branches after their death, usually caused by overshading and consequent poor nutrition. In this process the tree is passive until the branch to be removed is dead, after which it is cut off by the formation of a " collar " of tissue by the cambium. This explains the absence of branches low down on the trunk when trees are crowded in growth. Such trees that have been pruned by environmental forces, as described above, furnish timber much freer from knots than that obtained from trees that have grown in the open, where the lower branches have persisted. Natural pruning does not appear to benefit a plant to any extent.

A second method, termed self-pruning, is described, which is distinguished from natural pruning in that the tree is an active agent in the process throughout. In this instance the branch dies as a result of the pruning, whereas in natural pruning the branch is pruned after it is dead. In some trees self-pruning is effected by the formation of an abscission layer similar to that formed at the base of leaf-stalks, and thus the branch is cut off from the tree. In other trees, as willows, instead of the abscission layer, a brittle zone is formed at the base of the branch. During the month of October the sapling poplars (*Populus deltoides*) in the New York Botanic Garden were vigorously pruning themselves, the ground being littered with branches, most of which are two years old, some older, some younger. These pruned branches bear well-formed winter buds. About twenty-five genera of plants growing in the garden exhibit self-pruning, amongst which are *Catalpa*, *Ailanthus*, horse-chestnut, elm, lilac, and mulberry. Some trees, as the red and the sugar maples, are self-pruned in spring or early summer, while others, as poplars, postpone the process until autumn.

The significance of self-pruning appears to be to get rid of superfluous or weak branches, and does not appear to be a means of vegetative propagation.

Madagascar Sedges used for Textile Purposes.

Certain species of *Cyperus* are used by the natives of Madagascar in the manufacture of hats and baskets of various kinds. M. P. Claverie has investigated the anatomical structure of these sedges, with the object of determining the special arrangement of tissues favouring the required amount of tenacity for textile purposes. Details are given in *Comptes Rendus*. The stem alone is used in *Cyperus madagascarensis*, *C. nudicaulis*, and *C. æqualis*, whereas both stem and leaves of *C. latifolius* and *C. alternifolius* are utilised.

The characteristic feature of the stem in each of the above species consists of the presence of a sub-epidermal ring of fibrous bundles, in addition to the normal more internal fibro-vascular bundles. In addition to this common character, each species named above can be recognised by the relative size and composition of the bundles, and by the conformation of the parenchyma.

In *C. latifolius* the leaf has two series of fibro-vascular bundles of different sizes, the largest are situated between the air cavities present in the parenchyma, the smaller series are situated outside the lacunose region, in the mesophyll between this region and the epidermis. In *C. alternifolius*, on the other hand, there is only a single ring of fibro-vascular bundles.

The author points out that with a knowledge of the morphology of the species of *Cyperus* utilised in textile industries it would be possible to determine the species used in the manufacture of any given article.

Resting Buds as Types of Plant Groups.

Raunkiaer, in *Bull. Acad. Roy. Sci., Danemark*, proposes a new classification of the higher plants, from an ecological standpoint, founded on resting buds and certain other structures present during the most severe portion of the year. This idea is founded on the assumption that those organs and structures of functional value during the most trying part of the season, being those which alone enable a plant to survive in a given climate, are of greater ecological value than the characters commonly derived from foliar characters. Five principal groups are given : Phanerophytes, buds well above the ground-level. Chamæphytes, buds slightly above ground-level. Hemicryptophytes, buds at ground-level. Cryptophytes, buds hidden in the ground. Therophytes, buds contained in the seed. The first group includes trees and shrubs; the last group embraces annual plants. Each of the primary groups is divided into many subsidiary sections, depending on such features as naked or scaly buds, evergreen or deciduous leaves, rhizomes, bulbs, &c.

The author considers that the above scheme of classification will lead to a more natural and accurate understanding of plant associations than those arrangements previously followed.

Nuclei in Embryo of Cypripedium.

Lula Pace, in *Bot. Gazette*, states that only four nuclei are present in the completed embryo-sac of *Cypripedium*. The *Lilium* and *Cypripedium* type have the fewest nuclear divisions from mother-cell to egg known amongst phanerogams. This shows only one more division than in the maturation of the animal egg.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Fixation of Nitrogen by Nodule-forming Bacteria.

THE treatment of leguminous crops with artificial cultivations of nodule-forming bacteria has not proved invariably successful. Mr. Moore attributed this to the use of too

nutritious culture-media, and found that by acclimatising the bacteria to poor media they were rendered more capable of fixing atmospheric nitrogen when applied to the plant. Practical experiments on a large scale, however, with other races of bacteria have not entirely supported this theory, and all the results obtained in Australia have been negative.

Dr. Greig-Smith, who has recently published the results of his interesting investigation of the action of these bacteria, confirms the assertion of previous workers that an actual fixation of nitrogen does take place in artificial cultures, and he describes certain points to be observed in the preparation of commercial preparations. When sections of the root-nodules of leguminous plants are examined under the microscope structures termed "infection cells" stretching from cell to cell may be observed. These consist of slime enclosing the bacteria, and similar slime may be produced in artificial cultures. In Dr. Greig-Smith's opinion this slime is a product of the bacteria, and is probably of use to the plant. Less than one per cent. of the bacteria present in a nodule are usually alive, but these are probably sufficient to maintain an active formation of products. Different races of bacteria differ as regards their slime-producing power in artificial media. In cultivations in which no formation of slime was observed there was no fixation of atmospheric nitrogen, while conditions promoting the production of slime also promoted the fixation of nitrogen. The formation of the root-nodules is to be attributed not to the irritation of parasitic action, but to the better nourishment of the plant cells in the neighbourhood of the bacteria.

The main constituent of the slime is a gum which dissolves in water and becomes gelatinous on the addition of acids. However carefully purified it invariably contains a considerable amount of nitrogen. The best yield of slime is obtained in culture-media containing saline and nitrogenous matters in about the same proportion as in soil water. As a rule the bacteria grow better in a neutral or alkaline medium, but certain races only produce slime in abundance in the presence of acid. Dr. Greig-Smith advocates the use of a mixed cultivation of active slime-forming bacteria, until such time as it shall have been proved that an *acidophile* race gives the better results. In his opinion there is true symbiosis between the bacterium and the plant, the latter supplying the saline and carbohydrate constituents, and the former producing the nitrogenous slime which can be utilised by the plant.

A New Miners' Lamp.

The principle of a lamp recently patented in this country by MM. Santa and Spelmans, of Brussels, depends upon the fact that certain flames, such as that of benzine, are constant in size and intensity so long as the environment remains the same, but are intensified by a gas such as fire-damp and reduced by carbon-dioxide. The flame of the lamp is protected by a casing of wire gauze provided with a series of external cooling ribs, and is surmounted by a chimney of refractory material. Through the opposite sides of this are inserted a series of elements forming a thermo-pile, the outer current from which passes through a galvanometer, which indicates any variation in the strength or direction of the current. Now, if fire-damp gain access to the lamp the flame becomes longer and hotter, the heat is conveyed to the thermo-elements, and an increase of electro-motive force is indicated by the pointer of the galvanometer. In like manner the reduction in the size and intensity of the flame by carbon-dioxide is indicated by a decrease in the electro-motive force. The lamp is made in portable or stationary form, and the galvanometer may be connected with a recording apparatus which will show the varying conditions to which the flame has been subjected in different parts of the mine.

Glass for Chemical Work.

The ordinary soft soda glass answers well enough for many purposes of the laboratory, but has the drawbacks of being easily shattered if exposed to sudden changes of temperature and of being attacked to a considerable extent by various reagents. Even boiling distilled water will dissolve an appreciable amount of alkali from the inside of a flask of soft glass. Hard Jena glass is much less soluble than ordinary glass, and is also less liable to break when suddenly heated or cooled, but still lacks some of the qualities of a perfect glass for chemical work. During the past ten years numerous experiments have been made on the construction of vessels of fused quartz or silica, but until recently these have not been commercially successful. Now, however, all kinds of apparatus may be obtained made of the new materials, and the present writer has received from Messrs. Gallenkamp and Co. specimen flasks made by a patent German process from quartz and by Dr. Shenstone's patent English process from silica. Both are more opalescent than ordinary glass, but are quite transparent. In hardness they are far superior to any known glass, and may be heated 800° C. above the melting point of soda glass without fusing. Their resistance to sudden changes of temperature is strikingly illustrated by the fact that they can be heated to redness in a blow-pipe flame and immediately plunged into cold water without being fractured. They are not dissolved by water or by acids, and are less affected by alkalies than vessels of ordinary or Jena glass. Their chief drawback is that as yet they are relatively expensive, although the vessels of fused silica cost considerably less than the German apparatus of fused quartz, and appear to be equally efficient.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

I AM indebted to Mr. J. T. Rodda, of Eastbourne, for photographs of the so-called paramoudra to be seen on the beach beneath the chalk cliffs at Cuckmere Haven, on the Sussex coast. The name has been given to them, no doubt, in consequence of the slight resemblance which they bear to the famous paramoudra of the Norwich chalk (Horstead), well-known in consequence of the often-times reproduced picture which appears in Lyell's Elements, "from a drawing by Mrs. Gunn." But whereas the Norwich instances are of flint, those at Cuckmere Haven are a beautiful white

Fig. 1.

chert, or siliceous limestone, in aspect not unlike the chalk itself. The largest of those illustrated stands at low-tide level, and measures 3 ft. 2 ins. high by 3 ft. 7 ins. broad, the central hole being 19 ins. by 15 ins. at its widest dimensions. About a quarter of a mile west of this, near the cliff, and a few yards to the east of the path down the cliffs, there are also some masses of chert, as well as two other chert rings between 3 ft. and 4 ft. in diameter. One of these is seen in our second illustration. The question arises as to whether these are organic or inorganic in their origin. No sponge structure has at present been detected in them, and

to call them paramoudra somewhat begs the question, as this term has already been applied to a form of gigantic fossil sponge. It is only fair to say, however, that even the Horstead specimens cannot be classed as organic in the opinion of Dr. G. Abbott, and this opinion is supported by Mr. Rodda, who says that it is his "idea that iron, manganese, silica, and lime, can, under certain favourable conditions, form cylinders, balls, rods, and plates." In the "South-Eastern Naturalist" (1907) Dr. Abbott illustrates a number of concretionary forms, and amongst them he includes the paramoudra of both kinds. An interesting question arises as to whence these chert-rings, or holed-stones, of Cuckmere Haven have been derived. Do they come from the chalk? None have at present been seen *in situ* therein. I suggest that they may have been derived from certain tertiary beds which are now missing. There are relics still of such beds at Seaford, and at Newhaven, and I suggest that some such beds may have left their less-easily denuded portions stranded on the shore after the destruction of the upper portions of the cliffs on which they stood. Mr. Rodda has sent me a portion of the chert from the Cuckmere rings, and it bears an exact resemblance to the material which I found some years ago in the tertiaries of Herne Hill, when an excavation some six feet deep had been made for drainage purposes. I am inclined to think that these chert-rings and masses are not from the chalk, but from eocene beds which have disappeared. The harder lumps still remain in the shape of these cherts, in a similar manner to that in which the sarsen stones of Wiltshire and the Sussex Downs, and the puddingstones of Hertfordshire, remain to attest the former presence of tertiaries where now none are found. Rounded pebbles of chert have been found in the Oldhaven beds, and the larger of these were adapted for use by neolithic man. Our third illustration shows the cliffs near where these stones are found, and the ditritus at the top of the cliff, about 10 feet thick, contains numerous fragments of similar material to that of the holed stones. One seeming difficulty should, perhaps, be mentioned, and that is, that the cherty rings contain flints, but the occurrence of these in tertiary beds merely shows that the material of the rings was derived in the first place from the chalk, and was afterwards, by chemical action, converted into that intimate association of silica and lime which we now call chert. In the fourth illustration the relative present position of the chert-ring, seen in the first illustration, to the chalk cliffs in the rear, is shown.

Fig. 2.—Another Chert-Ring, in which the hollowing process is at a less advanced stage. The hole is filled by a large stone.

Fig. 3.—Cliffs at Cuckmere Haven, showing deposit at the top containing chert.

Fig. 4.—Chert-Ring in the foreground, and chalk cliffs at the rear.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

The Dispersal of Fog.

A COUPLE of months ago the attention of the Public Control Committee of the London County Council was directed to the proposals of Signor Demetrius Maggiora "to prevent the formation of fog or to disperse it in case it is already formed, and also to disperse and destroy all clouds and to prevent rain, hailstorms, lightning, and thunder." The inventor claims that this can be effected by means of explosions of acetylene or other gas in a strong steel cannon about 60 ft. high and 6 ft. in diameter. The Committee asked Dr. W. N. Shaw, the Director of the Meteorological Office, to examine and report on the proposal and its suitability to the atmospheric conditions of London.

Dr. Shaw, in his report, says: "The apparatus which Signor Maggiora now offers for removing London fog is

apparently on similar lines to that supplied in Italy for dispersing hailstorms. From the scientific point of view hail affords a much more specious opportunity for human interference than fog. The atmosphere is then in a state of great commotion preceded by abnormally unstable conditions. A London fog is incidental to conditions of unusual stability, and Signor Maggiora's memorandum suggests no physical process which could produce any effect in accordance with the known physical properties of the atmosphere. It may be remarked that the weight of a cubic mile of air is about five million tons, and, consequently, the weight of fog-laden air in the case of a fog a mile thick extending over the district of greater London alone is 3,600 million tons. It is obviously useless to attempt the motion of so great a mass by mechanical means. . . .

"I may sum up by saying that the claim to prevent or disperse fog is entirely unsupported by any evidence, the claim to prevent rain is opposed by the more frequent claim of similar processes to produce rain in countries which suffer from drought, and the claim to affect hailstorms (which is associated with that regarding thunder and lightning) is not allowed by the scientific experts of Austria and Italy who have conducted special investigations on the subject for their respective Governments."

The Committee subsequently made the following recommendation to the London County Council, which was agreed to:—"That the Main Drainage Committee be authorised to allow Signor D. Maggiora the use of a site, on land held for main drainage purposes, in order to enable him to conduct experiments with his apparatus for the prevention and dispersal of fog, and that the grant of any such facilities to Signor Maggiora shall be made on the distinct understanding that the experiments are not being carried out under the direction of the Council, and that the name of the Council shall not be used in any way in connection with any application for financial aid for working the invention."

Hail Shooting in Italy.

Professor Cleveland Abbe, in the United States *Monthly Weather Review* for August, 1907, says that the references to this subject in previous volumes of that publication have abundantly shown the probability that there is no rational basis for the efforts made in Italy and France to break up thunderstorms and prevent injurious hail by some method of cannonading. Neither the noise, nor the smoke, nor the heat, nor the commotion produced by grand vortex rings can be expected to have any considerable influence on the enormous cumulus clouds from which hail and lightning proceed.

This conviction is now confirmed by a report read before the Royal Academy of Sciences at Rome on December 2, 1906, by Senator P. Blaserna, who is also Professor of Physics in the Royal University at Rome, and President of the Accademia dei Lincei. In 1902 Professor Blaserna was appointed by the Italian Government president of a special commission to investigate this subject. A locality that had suffered extremely in previous years was chosen as the field of operation, viz., Castelfranco in Venetia, and 222 cannon of the most approved special type manufactured by the Greinitz Company were established; each of these sends up a vortex ring 13 ft. in diameter, and one additional cannon sending up a vortex 45 ft. in diameter was subsequently added. As these vortices failed to ascend higher than 200 or 300 yards, they evidently had no effect on the clouds; therefore a higher station, the Casa Aulagne di Monteux, was occupied, so that the vortex rings attained 1,200 yards, but still no good results were perceived.

Then the Secretary of War and the manufacturers of pyrotechnics were appealed to. Of the latter, Marazzi, at Rome, succeeded in constructing bombs weighing 18 lbs. that were carried up to 2,500 ft., where they exploded. During 1906, 250 broadsides were fired by the 222 cannon at Aulagne, and 60 of the Marazzi bombs were sent up, but still no good effects were perceptible. These negative results of a five-years' campaign justify the commission in recommending that the Italian Government no longer encourage such expensive and useless work.

The Teaching of Meteorology in Schools.

During the last few years the Royal Meteorological Society has endeavoured to promote an intelligent public interest in the science of Meteorology, by appointing a Lecturer to give information on meteorological subjects to scientific societies, institutions, and public schools in various parts of the country, and also by arranging Meteorological Exhibitions in connection with the Royal Agricultural Society's show and other gatherings. The Council now desire to encourage the teaching of facts regarding Weather and Climate in Schools, and they are inviting Elementary Teachers and others to send in Essays in the form of an original Nature Study Lesson on Weather or Climate (not exceeding 1,500 words in length), together with a brief synopsis of five other Lessons to cover the whole subject of Climate and Weather. If Essays of sufficient merit are received, three Prizes will be awarded of £5, £3, and £2 respectively. The Essays are to be sent in before January 31, 1908. This Prize Competition will no doubt stimulate many teachers to take an interest in the subject and to impart to their scholars some definite teaching on such common and everyday matters as the weather and climate.

Lectures on Rainfall.

The intimate relation of Meteorology to Geography is shown in the announcement that the Royal Geographical Society has arranged for Dr. H. R. Mill to give a course of six Lectures on "The Geographical Distribution of Rainfall in the British Isles." These will be delivered in the Map Room of the Society on Thursday evenings in January and February, commencing on January 23 at 5.30 p.m. Dr. Mill will deal with the subject as follows:—Lecture I., "The Physical Geography of Great Britain and Ireland"; Lecture II., "Rain: its Nature, Origin, and Functions"; Lecture III., "Measuring, Recording, and Mapping Rainfall"; Lecture IV., "The Duration and Distribution of Showers"; Lecture V., "Average Annual Rainfall"; and Lecture VI., "Rainfall in Relation to Configuration and to Economic Conditions."

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Birds Peculiar to Great Britain.

DR. ERNEST HARTERT, in the December issue of "British Birds," contributes a paper on the races of birds which he contends are to be regarded as distinguishable and peculiar to Great Britain.

That is to say, he holds that certain species—no less than 22 in number have, by isolation, or other causes, become differentiated from their Continental relatives.

The Jay, for example, the first in his list, differs from the Continental Jay—which occasionally visits us—by its more uniform villous upper surface, which lacks any grey or slatey tinge on the back.

Of the Cross-bills he distinguishes two races, one English, and one confined to Scotland; but we cannot resist a feeling that here, as in some other cases, he is stretching the evidence beyond what it will fairly stand.

The Pied and Yellow Wagtails, Great and Blue Tits, Coal Tit, Marsh Tit, Willow Tit, Long-tailed and Crested Tits are all distinguishable from Continental birds. And so, also, are the Goldcrest Nuthatch, Tree-creeper, Robin, Wren, Dipper, and Great and Lesser Spotted Woodpeckers. Those who desire to know the grounds on which these distinctions are made should read Dr. Hartert's paper, which is most interesting.

A New British Bird.

Dr. N. F. Ticehurst, in "British Birds" for December, records the fact that a semi-palmated Sandpiper (*Erenentes pusillus*) was shot on September 17, 1907, at Sunny Gap in Romney Marsh. It was an immature bird, in autumn plumage. This is not only the first recorded instance of the occurrence of the bird in Great Britain, but it is the first record of its occurrence in Europe. It is an American species, we should remember, and resembles the "Little

Strut" rather closely, but may be distinguished therefrom by the larger beak and the webbing of the toes.

Icterine Warbler in Norfolk.

In this same issue of "British Birds" (December), Mr. E. C. Arnold records the occurrence of the Icterine Warbler in Norfolk, an example of this species having been killed on September 17 near the Blakeney sand-hills.

Red-breasted Snipe in Kent.

Dr. N. F. Ticehurst, in "British Birds" for December gives a brief note of a Red-breasted Snipe which was killed on August 14 at Littlestone, in Kent. It was an adult male, and changing from summer into winter plumage.

Late Nesting of Lapwing.

The *Field*, December 7, contains a record of the fact that a Lapwing, with three chicks, was taken during the last week in November, in Devonshire.

PHYSICS.

By PROFESSOR ALFRED W. PORTER, B.Sc.

Radium Emanation in the Atmosphere.

"IT has been proved by Elster and Geitel that a negatively-charged wire, exposed for a few hours in the air, receives a radio-active deposit similar in character to the quick-changing products of radium. Radium is known to be widely distributed amongst the constituents of the earth's crust. Moreover, there is evidence that the emanation from the radium in the earth escapes into the atmosphere. From this emanation arise the active deposits of radium in the atmosphere. The radio-active changes in the air and soil account for the ionisation of the air, and important electric and meteorological effects result, the characters of which are at present imperfectly understood." In this way Mr. A. S. Eve introduces a description in the *Philosophical Magazine* of his recent experiments to determine the amount of emanation in the atmosphere, expressed in terms of the quantity of radium required to keep the supply constant. His conclusions from these experiments are:—The emanation in the atmosphere is absorbed by cocoa-nut charcoal; its presence can be proved and its magnitude determined. The amount of radium required to maintain the supply of emanation per cubic metre constant is about 80 by 10^{-12} grams. This emanation is of the correct order of magnitude to account for the active deposits of radium C, which may be collected on negatively-charged wires from the atmosphere. In brief, the radium in the earth near its surface, the emanation in the atmosphere, the resulting active deposit, the penetrating radiation due to all these, the ionisation in the atmosphere, exist in corresponding amounts, so that they can all be correlated.

Daily Variation of Terrestrial Magnetism.

Some years ago Professor Schuster proved that the diurnal variation of terrestrial magnetism had its origin outside the earth's surface, and he drew the natural conclusion that it was caused by electric currents circulating in the upper regions of the atmosphere. To account for these currents he sees no alternative to a theory first proposed by Balfour Stewart, that the necessary electro-motive forces are supplied by moving masses of the atmosphere cutting through the earth's magnetic field. In other words, the supposition is that currents similar to Foucault currents are produced in the air as it oscillates backwards and forwards. If this is so the air which is taking part in the action must have considerable electric conductivity. In support of this idea he shows that both the diurnal and semi-diurnal variations are caused by an oscillation of the atmosphere, which is of the same nature as that which causes the daily variations of barometric pressure. It is possible that the magnetic changes are due to movements only in the upper regions of the atmosphere, and these—owing to the rarity of the air there—do not affect the barometer much. It is possible, therefore, to account for discrepancies by assuming independent movements of the upper and of the lower regions of the atmosphere. Now, the conducting power of the air depends upon the amount of ionisation in it, and this, in turn, depends probably upon the amount of solar radiation. Hence, we might expect an increased conducting power in summer and in daytime as compared with winter and night. In conformity with this explanation we have also the fact that magnetic changes are considerably greater in summer than in winter, and we know that the needle is at comparative rest during the night.

Selective Reflection from Salts.

When the radiation reflected from various salts is examined, well-marked maxima are found. In extension of the results of other observers, Mr. L. B. Morse has recently examined the light reflected from a series of carbonates. The experiments were made with infra-red radiation. Three bands of marked reflexion were found in all of the specimens examined, but in no case were there more than three bands found in the spectrum between wave-lengths of 4 and 15 μ These reflection bands are distinct from those obtained for salts of other acids that show reflection maxima; this indicates that they are due to the acid radicle. The positions of the bands are not quite the same for the various salts examined. In general, the larger the atomic weight of the base, the greater is the wave-length to which any band corresponds. No simple relation appears to hold between the positions of the three maxima. It is suggested on certain grounds that it is the oxygen present which gives rise to them.

ZOOLOGY.

By R. LYDEKKER.

Flies in Liverpool.

LIVERPOOL is endeavouring to organise a crusade against flies, which are now admitted to play an important part in the dissemination of disease. Their breeding-places in the city have been ascertained, their developmental history has been carefully worked out, and suggestions are made as to the manner in which their extraordinary rate of multiplication can be readily checked. It will be interesting to see whether the suggestions will be acted upon, and if so, whether any perceptible diminution of these insects in the city will be noticeable next summer.

A Rhinoceros Mummy.

The *Illustrated London News* recently reproduced a photograph of a mummified rhinoceros—presumably the woolly Siberian species—discovered in the oil-strata of Austrian Poland. The skin of the head, of one fore-limb, and of a considerable portion of the body is preserved, and appears to be in wonderfully good condition. The preservation of the soft parts is due, of course, to the oil in the stratum, which has probably converted much of the tissues into a kind of adipocere. Although horns of the aurochs have been discovered in peat, this is the first instance that has come under my notice of the preservation of the skin of an extinct animal in oil.

The Californian Elephant-Seal.

One of the animals supposed to be extinct, and, at any rate, hitherto unrepresented in any European museum by an adult male, is the Californian representative of the elephant-seal, or sea-elephant. Whether it be a distinct species or a local variety of the more southern animal—the most gigantic member of the whole seal tribe—is a matter of little moment. Fortunately for science, a collector sent out by Mr. Rothschild discovered a small herd on Guadeloupe Island, off the coast of Lower California, and was successful in securing half-a-dozen specimens, and likewise several photographs of the animals as they lay reposing on the beach. Whether he made a clean sweep of the herd is not stated. In case any-

one should be disposed to urge that such wholesale slaughter is unjustifiable, it may be stated that sealers would be almost certain to have visited the island before long and killed every one of the "elephants"; and it is most assuredly far better that the Guadeloupe monsters should find permanent homes in the museums of this country, rather than be slaughtered for the sake of their oil and hides. It may be added that till the recent destructive fire in that city, one adult male of the Californian elephant-seal was preserved in the museum of the Academy of Sciences at San Francisco.

Some Interesting Animals.

During the last few months several large mammals of more than ordinary interest have been added to the public galleries of the natural history branch of the British Museum. Among these are a mounted skin and a skeleton of the wild horse of the Gobi desert, both presented by the Duke of Bedford. The skeleton has been referred to recently in a paragraph which has gone the round of the daily papers; but the writer of that paragraph seems to have been quite unaware of the existence of the mounted specimen, which is, of course, much more interesting to the general public—one horse skeleton being very like another. To the exertions of a well-known sportsman, Mr. Van der Byl, the museum owes a fine specimen of that beautiful antelope, the Beatrix oryx of Arabia, a species which has long been a desideratum in the public galleries. A still greater novelty is a mounted specimen of the great black forest-hog of equatorial Africa, a species whose very existence was only made known a few years ago. Mr. G. C. Whitaker is the donor of this specimen, which is the only one in the collection fit for mounting. Mr. Meinertzhagen, the discoverer of this species, had, however, previously presented portions of the skin and a skull; while another skull was given a couple of years ago by Colonel J. J. Harrison.

Big Elephant Tusks.

In reference to a statement in the article on African elephants in last month's "KNOWLEDGE," it appears that the largest known tusk is one from East Africa in the possession of Sir E. J. Loder, which measures 10 feet 4 inches long, with a girth of 26 inches, and weighs 235 lbs. The longest tusks are a pair from East Africa recently in the possession of Rowland Ward. Their respective lengths were 11 feet 5½ inches and 11 feet, and their united weight 293 lbs.

Papers Read.

At the meeting of the Zoological Society on November 23 a paper by the Rev. O. Pickard-Cambridge on spiders was read by the Secretary, in which seven species were described as new. In a second paper Mr. M. Jacoby described some new chrysomelid beetles from South America; while in a third Mr. E. S. Russel referred to certain modifications of the shell of the limpet in adaptation to local conditions. Mr. F. E. Beddard contributed an account of the anatomy of the toads of the family *Pelobatidæ*; Lord Walsingham described the Microlepidoptera of Teneriffe; and Mr. R. I. Pocock read notes on Liberian mammals, two of which were regarded as new. Mr. J. Hopkinson communicated particulars with regard to the dates of publication of the parts of the 13th edition of the "Systema Naturæ." At the meeting held on December 10 the origin of mammal-like reptiles formed the subject of a communication from Dr. R. Broom; Mr. G. A. Boulenger presented a revision of the African catfishes of the genus *Clarias*; and Professor E. A. Minchin discoursed on a parasite from the blood of a Himalayan lizard.

REVIEWS OF BOOKS.

ANTHROPOLOGY.

The Native Races of the British Empire: Natives of Northern India, by W. Crooke (London: Archibald Constable and Co., Ltd., 1907, pp. xiv. and 270, illustrated; price 6s. net).—Anything tending to bring home to the minds of the untravelled section of the British public the fact that among their Indian fellow-subjects are included races differing from each other to a greater degree than does a Norwegian from a Basque or a Frenchman from a Magyar, is a distinct gain at any time. At the present time such a stimulus to a right conception of the duties and responsibilities inseparable from a world-wide empire is more important than ever. The appearance of the present work, which deals with the more stalwart and warlike nationalities of India is, therefore, peculiarly opportune; and it is sincerely to be hoped that it may prove in some degree a counterblast to the absurd and senseless cry of "India for the Indians." This, however, is but a secondary and incidental attribute of the work before us, which is, likewise, to be commended as an excellent summary of the leading physical features, customs, and relationships of the numerous races and tribes collectively forming the native population of the northern half of our Indian empire. We write summary advisedly, for in a volume of less than 300 pages it is, of course, an absolute impossibility to give anything more than an outline sketch of such a vast subject. The author, we are glad to find, is a member of the Indian Civil Service, who has passed a number of years in the country of whose inhabitants he writes; and since he appears to have devoted a considerable amount of time to anthropological and ethnological studies, his accounts may be accepted as trustworthy and authentic. We are specially glad to find that he is thoroughly sound in connection with those much misunderstood terms Aryan and Dravidian; impressing on his readers that they are merely language-designations, and that any such title as "Aryan race" is practically an absurdity. In connection with the Dravidian stock, as exemplified by the Gonds and Bhils of Central India, we notice, however, that the author finds himself in a difficulty, mainly owing to his lack of acquaintance with modern anthropological literature. As we read on page 26, he appears to be convinced that there is some sort of relationship between the Dravidian-speaking nationalities of India and the natives of Australia, and yet he finds great difficulty in explaining this, owing to the supposed Negro affinities of the latter. Had he but realised that Australians, like Dravidians, are now regarded by many of the best authorities as low-grade Caucasians, his difficulties would have vanished. It may also be mentioned that it would be an improvement to this and the other volumes of the series if the words "Natives of" were added to the back of the covers, since such titles as "Northern India" and "British East Africa" give no clue to the real subject of the volumes. In other respects we have nothing but commendation to bestow on Mr. Crooke's accurate, and at the same time picturesque, account of the natives of the central and northern provinces of India.

ASTRONOMY.

Catalogue of Earthquakes on the Pacific Coast, 1897 to 1906, by Alexander G. McAdie. From Vol. 49 of the Smithsonian Miscellaneous Collections.—This is a continuation of a previous catalogue due to Professor Holden, and also published in the Smithsonian Miscellaneous Collections in 1898. The sources of information include the U.S. Weather Bureau, the Lick and other Californian Observatories, including the Naval Observatory at Mare Island, and the U.S. Geological Survey. In 60 pages we have details, often very meagre, consisting only of the date and locality, of something like 700 earthquakes, of which 1906 provides about three times as much as its normal share; including, of course, the great San Francisco earthquake of April 18, which alone demands eight pages, six pages being the average required for a whole year. No analysis of the records is made with reference to distribution in time or place, but that invaluable Smithsonian Institution continues to provide in this and similar summaries a mine of information all ready for the investigator. When will anybody endow a similar institution for this country? The Royal Society, the British Association, and similar self-supporting bodies do a great deal, but all are handicapped financially, so that much work that is planned has to be left undone.

Celestial Motions: A Handy Book of Astronomy, by W. T. Lynn. 11th edition, revised. (London: Bagster,

XUM

1907; 125 with 5 plates; 2s. net).—Once more the march of discovery has enabled the author to add a few sentences here and there to his work, which originally appeared in 1884. Professor Todd has incorporated practically the whole of the book in a larger work called Stars and Telescopes, with full acknowledgment to and permission from the author, who feels, however, that the less ambitious work still meets a demand among those who do not wish to go deeply into the subject. He has consequently brought out a new edition, stamped with his, we might almost say "proverbial" accuracy and erudition, inserting, to bring it up-to-date, such recent discoveries as the 6th and 7th satellites of Jupiter, and the 9th and 10th satellites of Saturn. We find chapters on the Earth, Moon, Sun, Solar System, Planets, Comets, Meteoroids, Fixed Stars, Constellations, Refraction, Propagation and Aberration of Light, and on the Calendar, succeeded by a useful dictionary of technical terms. Altogether a very admirable *multum in parvo*.

CHEMISTRY.

Systematic Practical Organic Chemistry, by G. M. Norman, B.Sc., A.R.C.Sc. (London: W. B. Clive; pp. viii. and 98; 1s. 6d.).—All the works issued by the University Tutorial Press are admirably adapted for the use of students preparing for examination, and this little book is no exception to the rule. It is intended primarily to cover the ground prescribed by the syllabus for stages one and two of the Board of Education's examinations in practical chemistry, and it does this in a concise and efficient manner; but at the same time it may be used with advantage by any student wishing to make his first practical acquaintance with organic chemistry.

Stereo-chemistry, by A. W. Stewart, D.Sc. (London: Longmans; pp. xx. and 583; 10s. 6d.).—The hypothesis of chemical stereoisomerism has been almost as far-reaching in its influence upon the development of chemistry as was Dalton's atomic theory. Its nature is best shown by an illustration. There are numerous compounds which are identical in chemical composition, but differ from one another in optical or other physical characteristics. Thus, to cite the classical instance first brought into notice, in 1860, by Pasteur, there are four chemically identical tartaric acids, but one of them rotates the beam of polarised light to the right, and another to the left, while the other two are inactive. The theory proposed by Wislicenus to explain this difference is, that the atoms in the respective molecules, though linked together in the same way, may yet differ in their relative positions in space. This theory of stereoisomerism, or the arrangement of atoms in space, has been developed, more especially by Professors van't Hoff and Le Bel, and supplies a satisfactory explanation of many previously inexplicable problems. The present admirable work is essentially a critical review of the stereo-chemical views of to-day, but at the same time it brings together and weaves into the fabric an immense number of facts scattered in various journals, and indicates numerous problems still awaiting solution. In this connection one of the most interesting portions of the book is the second appendix, in which is discussed the relationship between stereo-chemistry and physiology. It is shown that there is often a pronounced difference in toxic character, or as regards their effect upon the senses of taste or smell between compounds which are chemically identical but physically distinct. The observed facts are still too isolated for anything more than rough generalisations to be made, but systematic study in this direction is certain to yield valuable results. Considered as a whole, this work, which is well printed and in clear type, may be recommended to all who have some knowledge of organic chemistry and are interested in the development of chemistry in the direction of physics.

NATURAL HISTORY.

An Outline of the Natural History of Our Shores, by J. Sinel. (London: Swan, Sonnenschein, and Co.; 1906).—This book should prove a boon to those who love hunting for the treasures of the sea-shore, and the delicious excitement of exploring rock-pools. It has the further advantage of reliability, having been written by one who has acquired an intimate knowledge of his subject by years of practical work. Mr. Sinel has furnished, in these pages, a most admirable guide to those who have a fondness for marine zoology, for he not only tells his readers what to look for, but also how their captures may be kept; either as living specimens or as specimens for the microscope or the museum. No group, from the Protozoa to the Fishes, is neglected; moreover, he has contrived to make his book something more than a mere collector's hand-book. It will prove as welcome in the study as by the sea-shore. In his directions for mounting large specimens on glass, he rightly points out that holes may be drilled through this by means of a drill such as is used by fretwork cutters. But the labour of this drilling will be greatly reduced if the point of the drill is kept flooded with turpentine. There will then be no need to make a preliminary scratch on the surface of the glass, as he recommends. As to illustrations, these are numerous, and have attained a high standard of excellence.

Woodlanders and Field Folk, by John Watson and Blanche Winder. (London: T. Fisher Unwin; 1907).—The authors have contrived to cover a great deal of ground in this small volume; but they are by no means to be congratulated on this achievement, for had they attempted less it is probable they would have produced a better book. As it is, it can only be described as a collection of scraps of information on many themes, tiresome to read, and by no means accurate as to facts; while, in an attempt at fine writing, they succeed only in producing extremely misleading pictures of the animals they affect to describe. Jays do *not* have blue wings; the water-vole is *not* a diminutive beaver, it would be just as accurate to describe the hippopotamus as a giant beaver! Buntings do *not* thrash straws. We do not see how, by "cultivating the acquaintance of the barn-owl," the ravages of the field-vole may be kept in check. The wings of the penguin are *not* rudimentary, and they are *not* featherless; it is misleading to speak of the restricted power of flight of the "giant penguin," since the penguins are all absolutely flightless. But the pages of this book are bristling with inaccuracies and errors of this description. Of the illustrations, one or two are good, the rest are either indifferent, or "fakes."

ZOOLOGY.

Guide to the Great Game Animals (Ungulata) in the British Museum (Nat. Hist.) (London: Printed by order of the Trustees, 1907; pp. viii. and 93; illustrated, price 1s. net).—The interest attaching to "big game animals," both on the part of the general public and, in still greater degree, of sportsmen seems fully to justify the new departure indicated by the issue of the profusely illustrated "guide" now before us. Hitherto the big game animals of the order Ungulata, that is to say, the hoofed mammals, have been included in the "guide" to mammals generally; but they have now a volume to themselves, in which they are treated at much greater length than was previously admissible. As the whole of the Ungulata are included, there are, of course, a certain number of species which cannot in any sense be properly regarded as big game; but this was inevitable, unless zoological arrangement was to be altogether superseded. An analogous remark will apply to the exclusion of the carnivorous big game. The volume is almost entirely illustrated by photographs from specimens in the Museum itself; in the case of heads and skulls, nothing better could in most instances be desired, but whether this method of illustration is altogether satisfactory in the case of entire specimens, we must leave our readers to judge for themselves. The book is a marvel of cheapness, and ought to command an extensive sale.

The Sense of Touch in Mammals and Birds, with Special Reference to the Papillary Ridges, by Walter Kidd (London: A. and C. Black; 1907; pp. viii. and 176; illustrated, price 5s. net).—Some years ago, there appeared in "KNOWLEDGE" an article on "Monkey Hand-Prints," in which attention was directed to the remarkable specific variations displayed by the fine, raised lines on the tactile surfaces of the hands and feet of apes, monkeys, and lemurs; the extreme complexity of type presented in this

respect by the last-named group being specially noted. The subject is amplified and elaborated in the present little volume, in a way that has never before been attempted, with a list of previous literature, in which, strange to say, no reference seems to be made to the article in this journal. The papillary ridges, as the structures in question are technically called, attain their full and typical development only in man, apes, monkeys, and lemurs, but the degree of specialisation does not by any means accord with the relative grade of those different groups in the zoological scale, simplicity of pattern being characteristic of the higher and complexity of the lower forms. This complexity of type in the papillary ridges of the lemurs, Dr. Kidd correlates with the special need for facility in maintaining the bodily equilibrium in creatures of purely nocturnal habits. The papillary ridges of both limbs are accordingly specially developed for assisting in this particular function, which he considered to be of greater importance than maintaining a firm hold on branches, hitherto regarded as one of the main uses of the structures in question. In man, on the other hand, a totally different state of affairs obtains; and the maintenance of equilibrium accordingly becomes confined to the papillary ridges of the foot, while those of the hand have a function altogether distinct. The author is to be congratulated on the pains he has taken to treat a very difficult subject in a philosophical and exhaustive manner.

MISCELLANEOUS.

"Education and National Progress," by Sir Norman Lockyer, K.C.B. (London: Macmillan and Co., Ltd., 1906; pp. xi. and 269; price 5s. net).—From 1870, the date of the appearance of the first of this collection of essays and addresses, to the present time, Sir Norman Lockyer has been incessantly preaching the necessity for a vastly increased national expenditure on education, accompanied by a corresponding augmentation in the number of State-aided Universities. Needless to say, the improved and up-to-date education for which he pleads so earnestly is one where science holds the main and dominating position, with modern languages in lieu of the classics. Basing his views (at all events in the closing sections of the volume) largely on the opinion that Britain is in danger of being outstripped in the industrial race owing to lack of technical education (and, shall we say, a disinclination for hard and continuous work?) among her sons, the author is optimistic as to results which would ensue from what we venture to call lavish expenditure by the State on scientific and technical education. Brain-power to guide and infuse new vigour into our commerce, and sea-power to guard the same, are, it is urged, two of the most essential needs of the country at the present day. On the latter object we have recently spent £120,000,000, while our Universities have not yet cost the nation a single million. In place of an annual expenditure of thirty millions, we ought to be spending a hundred. "It cannot be doubted that the expenditure will be quickly remunerative." While endorsing to a great extent the author's views, Mr. Haldane, who has contributed an introduction to the volume, utters a note of warning. "Probably," he writes, "nothing conduces more to national efficiency than frugality in the use of national resources. The private donor should be encouraged, and left to extend his generosity in regions which do not concern the State generally. In writing this I do not mean that the Government ought not to spend public money generously upon the Universities. I mean that it should not be spent unless and until a case for the necessity of such expenditure has been clearly made out." Whether the extreme views of the author meet with general acceptation, it cannot be doubted that the present volume should be in the hands of every member of the Government of the day, as well as in those of all connected with the higher education, to say nothing of parents who have sons of their own to educate. That Sir Norman has been well-advised in re-issuing this stirring series of essays and addresses no one interested in the welfare and progress of Great Britain will presume for one moment to doubt.

The Literature of Roguery, by Frank Chandler. Types of English Literature Series, edited by Professor W. A. Neilson (London, 1907: Constable; 2 vols. 12s.).—The rogue in fiction, gay, irresponsible, mischievous, rather than malevolent, has always achieved a distinguished popularity from "Gil Blas" downwards. Who, for instance, does not feel his heart warm towards Alfred Jingle, with his audacious impudence and humorous adroitness, but Alfred Jingle is merely an incident in Mr. Pickwick's career, and it is with the rogue as hero, or, rather, as anti-hero, that Mr. Chandler is properly concerned. He is here subjected to an elaborate scientific dissection and analysis, his scope in literature is defined, his genesis and development examined and traced with an exhaustive and detailed precision never before devoted to the subject. The result is a work, admirable both in its matter and arrangement, and provided with full bibliographies which will be invaluable to students. The study of roguery also involves the study of realism in fiction; it includes an investigation of the part played in literature by the observation of low life. This is especially true of the Spanish picturesque novel from which the type took its origin. Its genesis is to be found in "La Vida de Lazarillo de Tormes," published in 1554, and Mr. Chandler defines it as "the comic biography of an anti-hero, who makes his way in the world through the service of masters, satirising their personal faults as well as their trades and professions." This type, thus to some extent a novel of manners, was matured in France, and became, through the medium of "Gil Blas," a potent influence on eighteenth century fiction. We cannot do more than touch in passing on the many curious and interesting bye-paths of literature which Mr. Chandler pursues, such as the chapter on "canting lexicons," and the slang of thieves and beggars; on the interesting summary of eighteenth century roguery in Defoe, Smollett, Fielding; on Sympathetic and Satiric realism in Borrow and Thackeray. Mr. Chandler's book exhibits an exhaustive industry. His array of facts is admirably marshalled before the reader, who is left to draw his own philosophic deductions from them.

French Readings in Science, by De V. Payen-Payne (London: Blackie and Son, 1906).—In 1904 the University of London made it essential that every candidate for a degree in Science should be able to translate a portion of a French and of a German scientific work. To assist such candidates the author has brought together a series of short excerpts from the works of various distinguished writers on scientific subjects. The scope of the chapters is wide, embracing every branch of science. The selection is certainly a good one, and we must heartily commend this book to all whom it may concern.

Life After Life, by Eustace Miles, M.A. (London: Methuen and Co., 1907).—This book deals with the theory of Reincarnation. It may afford amusement to some people; for ourselves, we find it inexpressibly stupid. It is doubtful whether, in any case, the theme is worth discussing on the lines laid down in these pages, but the author certainly shows no sort of qualification for the task he essayed.

BOOKS RECEIVED.

Thomas Alva Edison, Sixty Years of an Inventor's Life. By F. A. JONES. (London: 1907, Hodder & Stoughton, pp. 376. 6s. net.)

The Bee People. ANONYMOUS. (London: 1907, Methuen & Co., pp. 124, 3s. 6d. net.)

Man and His Future. By LIEUT.-COL. W. SEDGWICK. (London: 1907, T. Werner Laurie, pp. 256, 8s. 6d. net.)

Penrose's Pictorial Annual, 1907-8. (London: 1907, Penrose & Co., Ltd., pp. 184, 5s. net.)

WE have received from Messrs. James Woolley, Sons, and Co., of Manchester, a copy of the Scientists' Reference Book and Diary for 1908, which is an extremely convenient little handbook, susceptible of being accommodated in the breast-pocket, and packed from cover to cover with useful scientific tables, data, and equations. The information contained in the book has been thoroughly revised and brought up to date by the addition of new facts and data.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page 288.*)

The drawbacks of the *freezing* process are that delicate tissues are apt to tear, that thin and regular sections cannot be obtained, and also that the freezing process itself may alter the arrangement of the cellular structures. On the other hand, for the rapid production of pathological sections without prior preparation, either in the postmortem-room or even during the actual carrying out of an operation (a method which is being increasingly utilised by some of our best-known surgeons), the freezing method is most useful, and the sections so produced have the further advantage of staining readily. There are some tissues, also, such as those containing fat, which would be spoiled by another method of treatment.

The advantages of the *celloidin method* are that the object does not require any heating, and that there is thus no danger of over-heating or charring. It is also easy of application and of manipulation during the various stages of imbedding, whilst the tissues are not likely to be damaged by being left too long in the solutions. For very brittle sections celloidin has a distinct advantage, and larger pieces can be cut than by any of the other methods. Finally, celloidin does not require removal from the tissues before mounting, so that it holds them well together. The disadvantages of the method are that the process is very slow, generally taking about three days; that the sections are rather thick, not much less than ten microns; that they fasten badly to the slides; that the process is unsuited for serial work; and that the celloidin itself stains deeply with aniline dyes.

The *paraffin* method is par excellence the method for serial sections, and for all fine and delicate work it is, I think, unrivalled. The paraffin is readily removed from the sections afterwards, and they stick well to the slides. Moreover, thinner sections can be cut by this method than by any other, and the tissues are well preserved. The disadvantages are that large objects do not cut well, nor do brittle objects, nor tissues, such as muscle and skin, which have a tendency to become brittle. The whole process requires care and attention both in the prior preparation before infiltrating, and in the regulation of the temperature during infiltration, if shrinkage and charring are to be avoided. But the process gives the finest results to the research student and regular laboratory worker, and is the best general method for really fine sections. Intelligently used, it will carry one triumphantly through apparently insuperable difficulties.

Cutting Sections by the Freezing Method.—Suitable instruments are the Cathcart microtome, the inexpensive student's microtomes made by Yung, Leitz, Bausch and Lomb, etc., the old-fashioned microtome, having a chamber of ice beneath the plate, and the plate microtome with spray. In the last two, the knife is held in a horse-shoe three-point suspension tripod, running on adjustable ivory points. One point is at each end of the knife, the other in the rear, and before starting to cut the knife must be adjusted so as to have its edge horizontal with the plate, after which sections are cut seriatim by a slight adjustment of the rear screw only. The other microtomes have an adjustable object-carrier, which simplifies matters and enables truer sections to be cut. Each microtome must, of course, be fitted with ether bottle, bellows, tubing, and the necessary ether points. It will be found that the latter have a tendency to clog, so that a spare pair of points is advisable if one's work is not to be at times disastrously interrupted. For the Cathcart type of microtome a plane iron in a solid wooden handle is better than a razor. Some of the Continental student's microtomes require special knives.

(*To be continued.*)

Royal Microscopical Society.

NOVEMBER 20.—The Right Hon. Lord Avebury, President, in the chair. Mr. Conrad Beck exhibited, under microscopes, two specimens of photographic plates prepared by the Lumière starch-grain process for colour-photography. One had been exposed and the other had not. The starch grains, which were about $\frac{1}{2000}$ inch in diameter, were stained red, violet, and green. If the object-glass of the microscope showing the unexposed plate be racked out of focus, so that the colours be blended, a very close approximation to white light is obtained. If the objective be only partially out of focus, patches and channels of colour are visible, due to the fact that the coloured grains are not sufficiently intermingled. These patches are what were seen under the microscopes on the table, to see the individual grains a much higher power than the $\frac{1}{4}$-inch used would be required. Mr. C. L. Curties (C. Baker) exhibited and described two inexpensive microscopes. The first, termed the "Nature Study" Microscope, was mounted on a heavy square foot. It was non-inclinable, and for observing large objects the stage and mirror could be removed and the specimen placed on the flat base. The other instrument is of similar design, but with special arrangements for enabling systematic examination to be made. Mr. J. I. Pigg exhibited a number of photomicrographic lantern slides from nature, showing the various stages in the development of the fern spore. Mr. Moffat exhibited and described a new form of filter for agar and other media. Dr. Hebb read a paper by Mr. Nelson on the Francois Watkins microscope. Mr. J. W. Gordon gave a *résumé* of his paper on mercury globules as test objects for the microscope. A discussion followed. The Secretary read a paper by Mr. Nelson, being his reply to Professor Porter's and Mr. Everitt's criticism of his paper on the limits of resolving power in the telescope and microscope. Professor Porter said he had seen Mr. Nelson's paper and had written a reply, which he read. Mr. Gordon offered some remarks, and said he hoped on a future occasion to make a contribution to the discussion. Mr. Moffat read a paper on light filters for photomicrography, exhibiting, in illustration of the results obtained, some excellent prints of Trypanosomes, bacilli, etc. Mr. E. F. Law gave a demonstration of the use of colour photography in metallurgy, exhibiting a number of photomicrographic lantern slides on the screen, showing the brilliant colours produced on the polished surfaces of alloys by the varying degrees of oxidation caused by the heat-tinting process.

Quekett Microscopical Club.

November 15.—Mr. D. J. Scourfield, F.Z.S., F.R.M.S. gave an account of a paper on "*Philodina macrostyla* and its allies," communicated by Mr. James Murray. It is proposed to re-define the genus *Philodina* as—toes, 4; eyes, cervical or none. Of the 26 admitted species 16 have eye-spots. These species are arranged in five groups. First, oviparous, spurs of moderate size. Second, oviparous, semi-loricated, small spurs. Third, parasitic, oviparous, with large, broad spurs. Fourth, oviparous, short spurred. Fifth, viviparous, long spurred. Some historical notes followed, and the paper concluded with a detailed account of the form and structure of the various species.

The Hon. Editor, Mr. F. P. Smith, made some remarks on "Some British Spiders Taken in 1907," mentioning in particular the work in the Huddersfield district done by Mr. William Falconer, of Slaithwaite. The species taken included, *Atypus affinis*, *Gnaphosa lapidosa sparassus viridissimus*, *Xysticus kochii*, the rare forms, *Attus caricis*, *Toxeus formicarius*, and *Amaurobius terrestris*. Also *Tarentula nemoralis* (Westr.), from Bexhill High Woods, a first British record.

Quekett Club Journal.

The half-yearly number of the Quekett Club Journal, just issued, contains a very practical account by Dr. Eugène Penard (Geneva), of his methods of collecting and preserving fresh-water rhizopods, which will be of service to workers in this and allied branches of natural history. The author gives methods of collecting from shallow ponds, streams, and marshes, on the one hand, and from deep lakes on the other, and explains how the material, when taken home, is to be treated by settlement or otherwise, and how any given object can be isolated. Instructions are given as to the treatment of siliceous scales, needles, etc., and three methods of mounting are explained in detail. Mr. F. Chapman gives a list of recent Foraminifera from Victoria; Mr. C. F. Rousselet describes a new variety of *Brachionus quadratus*, and gives a note on *B. rubens*; Mr. E. Ellingsen (Norway), contributes some notes on British and foreign Pseudo-scorpions; Mr. G. P. Deeley describes three water-mites, new to Britain; and Mr. F. P. Smith, describes some British spiders, taken in 1907. The rest of the volume contains the usual notices of books, reports of Proceedings, etc., and six excellent plates.

Collecting Foraminifera.

In the last issue of the Quekett Club Journal (referred to above), in the reports of the Proceedings, Mr. A. Earland gives an account of his methods of collecting foraminifera, which may be of service to many of my readers. Judging by the number of applicants for recent distributions of foraminiferal material, there must be many who take an interest in these beautiful organisms, so that I venture to reproduce the substance of Mr. Earland's remarks here, referring those interested to the original Journal for further particulars, and for some interesting remarks on the "dimorphism" of the Foraminifera. Mr. Earland said that probably everyone had noticed that on most sandy beaches the sand in the ripple-marks was of a different colour to the rest of the sand. It was generally white through the presence of Foraminifera and fragments of molluscan shells, but it was sometimes dark, or black, owing to ashes or coal-dust from the steamers. This deposit could be scraped together and collected by means of a slip of glass or a "Frena" film of celluloid, dried carefully at a moderate heat, and the coarser particles sifted out through a wire gauze of about twenty meshes to the inch. The fine material which passed through the sieve would be sand grains, Foraminifera, Ostracoda, Bryozoa, and fragments of shells. The specific gravity of the sand grains enabled them to be easily got rid of, but the Ostracoda, and other objects of similar weight could not be separated mechanically. If, however, the dried material was placed in water, and stirred up, some would remain suspended or floating on the surface after the rest had settled to the bottom. This could then be decanted off and poured through a sieve of 120 to the inch, and, after drying, would be found to consist of almost entirely perfect Foraminifera of the smaller and lighter forms, with Ostracoda and small Mollusca. Great care should be exercised in these floatings, as they included the best and most delicate specimens. The quantity of the floatings varied greatly, a muddy shore yielding the most. To separate the heavier specimens from the sand, the material from the bottom of the vessel is poured into a shallow tray, such as a developing dish, covered with about an inch of water, and gently "rocked" with a sort of circular, sweeping motion. This causes the light calcareous particles to rise to the surface of the layer of heavier sand-grains, and to collect in eddies. At the proper moment, quickly learned by experiment, the water is rapidly poured on to a sieve, carrying the Foraminifera, etc., with it. The process is repeated until only sand is left. The material on the sieve is then carefully dried and can be kept in dry tubes until required. Dredgings and silt are similarly treated, but much mud should be removed first by washing the material on a sieve of 120 or 150 to the inch, under a gently-running tap.

Notes and Queries.

Lantern Slides.—Mr. C. Baker, of 244, High Holborn, has sent me a list of lantern slides which can be either bought or hired. They include photographs taken with an ordinary camera from nature or from drawings, such as those of birds and birds' eggs, fishes, mollusca, arachnida, &c., and those taken with the microscope and camera, including arachnida, insects of all kinds, foraminifera, marine and pond life, botanical sections, diatoms, and histological, bacteriological, and pathological sections. Particular attention is due to certain sets which are listed for sale or hire, each containing two or three dozen slides, all of which are described in well-known books, like Wood's "Common Objects of the Microscope," Cooke's "One Thousand Objects for the Microscope," Kerr's "Hidden Beauties of Nature," and other books by Kerr, Steven, Scherren, and Lewis Wright. This is an original idea and should prove popular. The list also includes Mr. Taverner's stereo-photomicrographs, recently exhibited to the Royal Microscopical Society and the Quekett Club, and already alluded to in these columns.

New Slides.—Messrs. W. Watson and Sons, of 313, High Holborn, have sent me four beautiful slides which they have just added to their collection. One is of the larva of the common gnat, *Culex pipiens*, which has been mounted without pressure, and shows clearly every natural feature of the living creature. The other three slides are of ants, which have been mounted from rare material that has not been utilised before, and include one of the Odontomachi and one of the species *Camponotus*, both from Old Calabar, West Africa, and the winged British ant, *Ponera punctatissima*.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabis Road, Cambridge, Correspondents are requested not to send specimens to be named.*]

XUM

The Face of the Sky for January.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 8.8 and sets at 3.59; on the 31st he rises at 7.44 and sets at 4.44.

The earth is nearest the Sun on the 2nd, when the Sun attains his maximum apparent diameter of 32′ 35″.

Sun-spots are not very numerous, though an occasional group may be observed on the solar disc.

There will be total eclipse of the Sun on the 3rd, invisible in this country, but visible over the Pacific, the track of totality lying almost entirely over water.

The positions of the Sun's axis, centre of the disc, and Heliographic Longitude, are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Jan. 1 ..	2° 23′E	3° 5′	0° 22′
,, 6 ..	0° 3′W	3° 39′	294° 31′
,, 16 ..	4° 51′W	4° 42′	162° 50′
,, 26 ..	9° 25′W	5° 36′	31° 10′
Feb. 5 ..	13° 35′W	6° 20′	259° 31′

THE MOON:—

Date.	Phases.	H. M.
Jan. 3 ..	● New Moon	9 43 p.m.
,, 10 ..	☽ First Quarter	1 53 p.m.
,, 18 ..	○ Full Moon	1 37 p.m.
,, 26 ..	☾ Last Quarter	3 1 p.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.	
			p. m.		p. m.		d. h.
Jan. 14	B.A.C. 1468 ..	6·5	3 53	69°	4 56	253°	10 18
,, 17	δ Geminorum ..	3·6	4 19	12°	4 34	340°	13 18
,, 18	B.A.C. 2788 ..	5·9	8 26	69°	9 33	298°	14 23

THE PLANETS.—Mercury (Jan. 1, R.A. $18^h\ 9^m$; Dec. S. 24° 32′. Jan. 31, R.A. $21^h\ 40^m$; Dec. S. 15° 37′) is in superior conjunction with the Sun on the 14th; towards the end of the month the planet is an evening star in Sagittarius but not well placed for observation.

Venus (Jan. 1, R.A. $20^h\ 37^m$; Dec. S. 20° 20′. Jan. 31, R.A. $23^h\ 1^m$; Dec. S. 7° 44′) is an evening star in Capricornus, setting about 7 p.m. on the 15th or nearly three hours after the sun. The planet is increasing in brightness, and should be readily discerned shortly after sunset. In the telescope the planet appears gibbous 0·9 of the disc being illuminated. The apparent diameter of the planet is increasing, being now about 12″.

Mars (Jan. 1, R.A. $23^h\ 36^m$; Dec. S. 3° 10′. Jan. 31, R.A. $0^h\ 52^m$; Dec. N. 5° 41′) is a conspicuous object in the evening sky, being due South about 5 p.m. at the beginning of the month and about 4.15 p.m. at the end of the month. During the early part of the month the planet appears in close proximity to Saturn, the latter being to the South, the ruddy colour of Mars, however, makes him readily distinguishable; as the month advances Mars separates widely from Saturn. The apparent diameter of the planet is diminishing, being about 6″; this, however, is too small for useful observation with telescopes of moderate power.

Jupiter (Jan. 1, R.A. $8^h\ 59^m$; Dec. N. 17° 52′. Jan. 31, R.A. $8^h\ 44^m$; Dec. N. 18° 56′) is a brilliant object in the evening sky looking S.E. The planet is in opposition to the Sun on the 29th, hence about this date he is South at midnight.

The bright moons can be seen in very small telescopes, or even in a pair of binoculars magnifying 6 or 8 times.

The equatorial diameter of the planet on the 16th is 44″·8, whilst the polar diameter is 2″·9 smaller.

The following table gives the satellite phenomena visible up to midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Jan.			
2	I.	Sh. E.	9 35
	I.	Tr. E.	10 13
	I.	Sh. E.	11 55
3	I.	Oc. R.	9 41
4	III.	Ec. D.	8 3
5	II.	Ec. D.	9 50
7	II.	Tr. E.	8 8
9	I.	Sh. I.	11 29
	I.	Tr. I.	11 58
10	I.	Ec. D.	8 39
	I.	Oc. R.	11 25
11	I.	Sh. E.	8 17
	I.	Tr. E.	8 44
Jan.			
14	II.	Sh. I.	6 42
	II.	Tr. I.	7 26
	II.	Sh. E.	9 38
	II.	Tr. E.	10 23
15	III.	Tr. E.	7 14
17	I.	Ec. D.	10 33
18	I.	Sh. I.	7 51
	I.	Tr. I.	8 8
	I.	Sh. E.	10 11
	I.	Tr. E.	10 28
19	I.	Oc. R.	7 34
21	II.	Sh. I.	9 17
	II.	Tr. I.	9 41
22	III.	Sh. I.	6 6
	III.	Tr. I.	6 48
Jan.			
22	III.	Sh. E.	9 48
	III.	Tr. E.	10 31
23	II.	Oc. R.	7 40
25	I.	Sh. I.	9 45
	I.	Tr. I.	9 51
26	I.	Ec. D.	6 55
	I.	Oc. R.	9 18
27	I.	Sh. E.	6 34
	I.	Tr. E.	6 37
28	II.	Sh. I.	11 52
	II.	Tr. I.	11 55
29	III.	Tr. I.	10 4
	III.	Sh. I.	10 5
30	II.	Oc. D.	6 58
	II.	Ec. R.	9 55

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (Jan. 1, R.A. $23^h\ 34^m$; Dec. S. 5° 14′. Jan. 31, R.A. $23^h 43^m$; Dec. S. 4° 10′) is a conspicuous object in the evening sky, being due South at 5 p.m. on the 1st, and at 3.5 p.m. on the 31st. At the beginning of the month Mars appears in close proximity to the planet, and the pair form a very noticeable object.

The ring appears closed, as we are looking at it edge on; in small telescopes, however, the dusky belt-like markings on the ball, although not so conspicuous as those on Jupiter, may readily be discerned.

Uranus (Jan. 16, R.A. $18^h\ 59^m$; Dec. S. 23° 8′) is in conjunction with the Sun on the 4th, and hence is unobservable.

Neptune (Jan. 16, R.A. $6^h\ 57^m$; Dec. N. 21° 58′) being in opposition to the Sun at the early part of the month, is on the meridian at midnight. The planet is situated one degree north of the star ζ Geminorum.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.
	h. m.		
Jan. 2-3 ..	XV. 20	+53°	Quadrantids.
,, 17 ..	XIX. 40	+53°	θ Cygnids.

Minima of Algol may be observed on the 2nd at 7.5 p.m.; 19th at 11 59 p.m.; 22nd at 8.48 p.m.; and the 25th at 5.37 p.m.

TELESCOPIC OBJECTS:—

Nebula.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star θ, is the finest of all nebulæ; with a 3 or 4 inch telescope, it is best observed when low powers are employed.

Double Stars.—β Orionis (Rigel), mags. 1 and 9, separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

ζ Orionis, triple, mags. 3, 6, and 10, separation 2″·5 and 56″; rather difficult in a 3-inch telescope.